RADIO and ELECTRONICS

Vol. 4, No. 3 May, 2 1949

OUR COVER:

This month's illustration is of the "Radel Broadcast Four," whose circuit, construction, and alignment are described in this issue.

Owing to circumstances beyond our control, it has been found impossible this month to continue the usual instalment of "A Practical Beginners' Course."

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A NEW PUBLICATION

One of the difficulties in producing a radio magazine in a country as small as New Zealand is that it is very difficult to cater for all possible tastes at the same time, yet, if the magazine is to be successful, it must do this to a large extent. The reason is, of course, that, while we have here just as many classes of person interested in radio—for one reason or another—as are to be found, say, in America, the population of each class is not great enough to make a monthly periodical a payable proposition if addressed solely to that class.

It is for that reason that the material which has been presented in *Radio and Electronics* over the three years or so of its existence has covered a particularly wide field, both in subject-mater and in the technical level of its presentation. In this way, we have attempted to print something in each issue, or in each two or three consecutive issues, that would appeal to all our possible readers.

Such a policy has certainly paid for itself, but undoubtedly brings difficulties in its wake. One of them is that, with a journal of only 48 pages, it is hardly possible to print a great enough number of articles in each issue for all possible tastes to be catered for in that issue. Because of this, periods have occurred in which there have not been, say, many articles for the amateur transmitter, or for the novice, or for those predominantly interested in audio work.

It has occurred to us, therefore, that there is one way in which we, as a publishing house, can render an increased service to the radio-minded community at large. It is by printing a book, of reasonable size, in which will appear all the essential constructional data that has been featured in *Radio and Electronics* over a comparatively long period. In this way, the complete range of interests can be catered for. Such a book, it is true, would contain nothing that has not already appeared in this journel, but to a great many people this will be no drawback.

It has, in fact, been decided to publish such a book, and at present it is hoped that it will be on sale at the same time as the July issue of *Radio and Electronics*. It will contain 96 pages, and will be of the same physical size as this journal. In it will be found all circuits, together with the necessary additional data such as parts lists, chassis diagrams, and photographs, of finished equipment that have been published since our maiden number in April, 1946, up to and including the December, 1948, issue. It is to be called, appropriately enough, *The Radio and Electronics Digest of Circuits*.

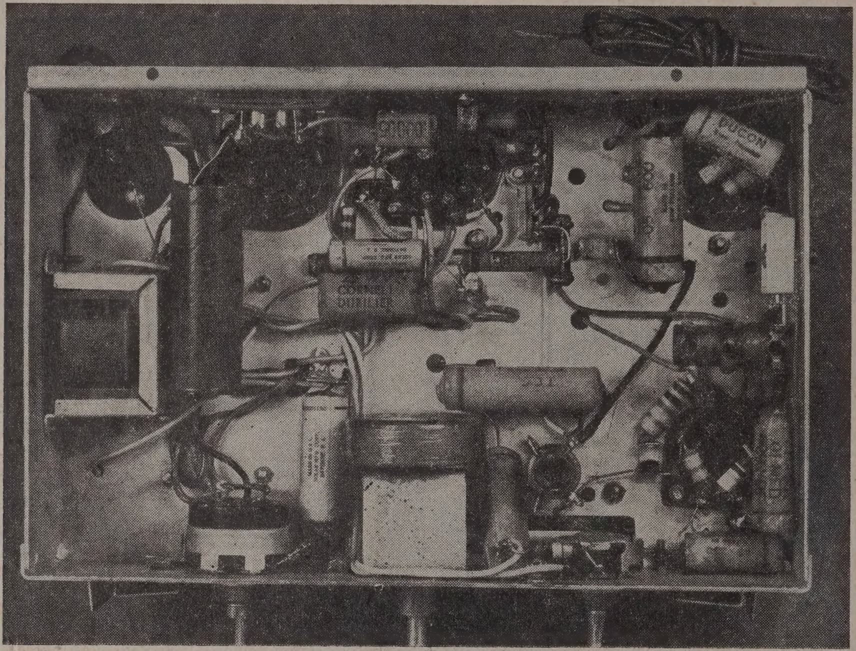
The *Digest* will be divided into sections, under headings such as Receivers, Audio Amplifiers, Test Equipment, Oscilloscopes, etc.; each section will commence with the most elementary circuits and work progressively through in order of complexity, so that constructors will easily be able to choose crystal sets, one-valvers, and so on, up to complex multi-valve sets. The price will be 2s. 6d.

We feel that this digest will fill a definite need in the present-day radio literature of this country, and that it will be useful to a wide variety of people, from those who have every issue of *Radio and Electronics* since its inception to those who have never bought a single copy. For the former, it will serve as an excellent reference book, which can be used while jobs are being done, without the danger of spoiling the carefully-filed copy of the original issue in which the circuit appeared. For those who have bought only some of our issues of the magazine, it will be useful in demonstrating the most important parts of the issues which they have missed, while for those who do not buy the journal the *Digest* may come, we hope, as a very pleasont surprise.

For those who have not read the full articles from which the circuits in the *Digest* have been culled, each will have a reference to the issue or issues in which the full description is to be found. Only one (December, 1946) is actually out of print, so that anyone who feels on reading the *Digest* that he must have the full article about any one item will be able to obtain the back number that is referred to.

THE RADEL 'BROADCAST FOUR'

Where a small receiver is wanted, with five-valve performance, but with a four-valve price, there is a continental valve that makes this possible. It is the EBL31, and this little receiver is designed round it.



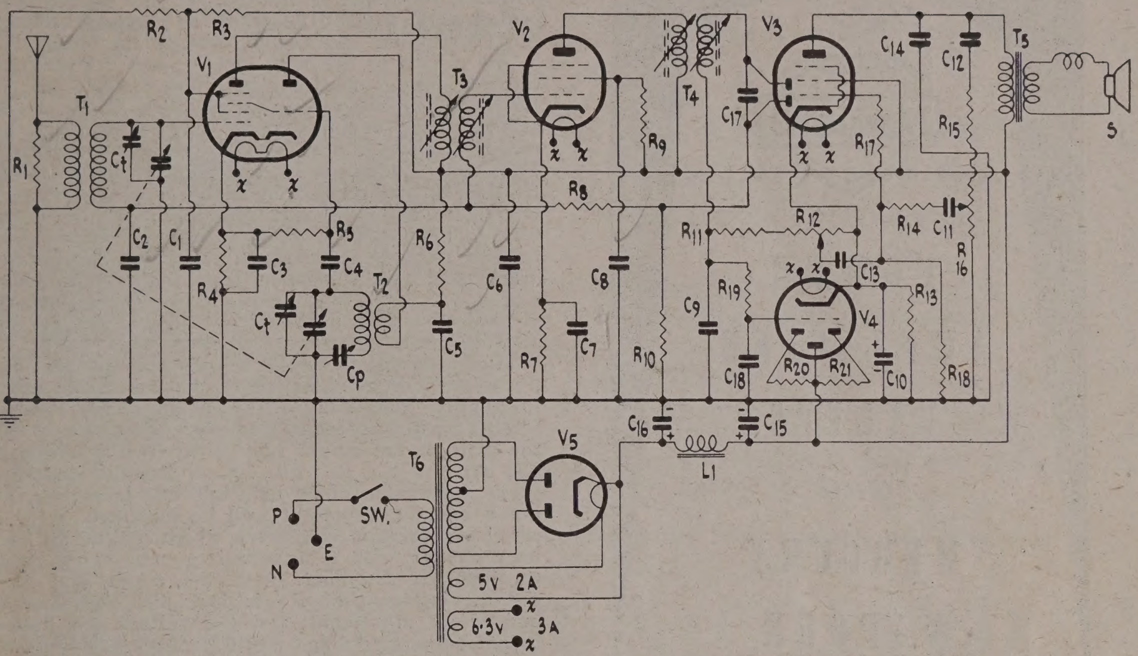
INTRODUCTION

In designing local receivers and small sets in which the size is to be kept down to a minimum, it is difficult, in the ordinary way, to go far past a conventional five-valve superhet. circuit, if the performance is not to suffer too much. That is to say, any tube line-up containing fewer than five valves must usually be content with a performance that can only be called "local stations only." This is a drawback for most people, because, even if the set remains tuned to the local stations for 95 per cent. of the time, it is very annoying if, for the remaining 5 per cent., the desired distant station cannot be received owing to limitations in the design of the set. The circuit to be presented here is one way out of this difficulty, and represents a really excellent solution to a long-standing problem. Even so, no difficult circuit "tricks" are employed, such as reflexing, and the set is as easy to construct and adjust as any normal five-valve arrangement. It uses full-sized valves, and yet can be built into a small space because only four working valves are used, including the power rectifier. A magic eye has been included, but may be omitted if it is desired to bring the cost down to its bare minimum.

THE VALVE THAT MAKES THIS POSSIBLE

If we are to have a set with a circuit which is almost the same as that of a normal "five," it almost stands to reason that an unusual dual-purpose valve must be included in the line-up, and this is, in fact, the case. The set is built round the EBL31, which is an English or continental valve, specially designed so as to reduce the tally of valves in a set by one. It has a 6.3 volt heater, and uses an octal base, so that there are not any difficulties about using this type in conjunction with the standard American series, if the constructor wishes to do so. At the same time, the valves used in the prototype were all from the same English series, for the sake of consistency, but we have indicated the changes that are necessary in order to substitute American types where this is possible. This can be done in all cases except that of the EBL31 itself, for which there is no American equivalent or near-equivalent.

The EBL31 is unusual in that it consists of a high-slope output pentode, combined with two diodes. The American manufacturers have put the same, or similiar, ideas into practice in producing valves in other series, but have nothing like it in the 6.3 volt series. How, then, does this valve help us to eliminate one valve from the usual line-up? The answer is to be found in the words "high slope," because the output pentode has the extremely high mutual conductance of 9.5 ma./v. This gives it a very high power sensitivity, which means that it needs only a very small audio signal on its control grid to produce its full rated output of 4.3 watts. Indeed, the D.C. grid bias needed is only 6 volts, so that an audio signal of only 5v. peak is necessary to swing it to



COMPONENT LIST

R_1, 5k.
R_2, R_5, R_6, R_{11}, 50k.
R_3, 35k. 1 watt.
R_4, R_7, 300 ohms.
R_8, R_{10}, R_{20}, R_{21}, 1 meg.
R_9, R_{15}, R_{17}, 100k.
R_{12}, 500k. pot., with Sw.
R_{13}, 150 ohms 1 watt.
R_{14}, 250k.
R_{16}, 250k. pot.
R_{18}, 500k.
R_{19}, 10 meg.
C_2, 0.1 μf. 400v.

C_1, C_3, C_6, C_7, C_8, C_{12}, C_{13}, 0.05 μf. 400v.
C_4, C_9, 100 $\mu\mu$f. mica.
C_5, 0.02 μf. 400v.
C_{10}, 25 μf. 25v. electro.
C_{11}, C_{17}, 50 $\mu\mu$f. mica.
C_{14}, 0.004 μf. mica 600v.
C_{15}, C_{16}, 16 μf. 450v. electro.
C_{18}, 0.002 μf.
T_1, aerial coil.
T_2, oscillator coil.
T_3, T_4, 455 kc/sec. I.F. trans.
T_5, output trans., 7000 ohms to v.c.

V_1, ECH35 or 6K8 (see text).
V_2, EF39 or 6K7 (see text).
V_3, EBL31.
V_4, EM34 (optional, see text).
V_5, 5Y3 or 5Z4.
Ct, trimmer condenser.
Cp, padder condenser.
Sw, On/Off switch on vol. control pot.
T_6, power trans., 280 v.-a-side, 60 ma.
L_1, 60 ma. smoothing choke.

full output. This amount of audio is readily supplied by the conventional diode detector of an otherwise ordinary receiver, so that by combining the highly sensitive pentode in the same envelope with two diodes, it is possible to dispense with the usual stage of audio amplification between the detector and the output stage, thereby using one valve less than usual, without in any way affecting the set-up of the R.F. end. The set, therefore, has just as much R.F. sensitivity as the usual five-valve set, and it is well known that modern "fives" have all the sensitivity that might be desired for listening to our own broadcast stations, whether local or distant.

At this point we can hear some readers saying that the same trick can be done with American valves by using a 6B8 as the combined I.F. amplifier, second detector, and A.V.C. rectifier, followed by a 6V6 in the usual way. Up to a point, this is true, but only up to a point, because the 6B8 has a smaller value of Gm than, say, a 6K7, and the 6V6 has nothing like the power sensitivity of the EBL31. As a result, a set along these lines would have neither the R.F. nor the audio sensitivity of the present line-up, and would tend to fall in the "locals only" class, as mentioned earlier.

It must be admitted, in all fairness, that the arrangement of the "Broadcast Four" does not have quite the audio sensitivity of a set with two audio stages, but this is only to be expected, and the effect in practice is a useful one, in that it is not possible to overload the power stage, however high the volume control is turned up. This is a great advantage in some circumstances, because it simply means that anyone operating the set cannot adjust the volume control in such a way that a ghastly distorted noise, masquerading as music, issues from the loudspeaker, in an attempt to get the greatest possible volume, to be an annoyance to the neighbours and anyone else within range!

THE CIRCUIT

Earlier in this article we stated that the "front end" of the set is similar to that of any normal five-valve set, and this is the case. The set has no R.F. amplifier stage, and starts off with an ECH35 or 6K8 as the oscillator-mixer, followed by an EF39 or 6K7 as the I.F. amplifier. In the usual line-up,

this would be followed by a 6Q7 or an EBC33 double-diode-triode, and then the output stage. Here, however, this valve is omitted, and the double-diode-pentode, the EBL31, serves as second detector, A.V.C. rectifier, and output tube, all at once.

The circuit of the R.F. end is quite conventional. Cathode bias is used for both the ECH35 and the EF39, which are also controlled by A.V.C. in the ordinary way. Iron-dust cored I.F. transformers, slug tuned, were used for best sensitivity and selectivity. The voltage divider in the screen circuit of the ECH35 is that recommended by the manufacturers, who state that this valve should be operated with fixed screen voltage rather than with a dropping resistor from H.T. On the other hand, the EF39 is better used with a dropping resistor than with a fixed screen voltage. There is no reason why the same general arrangement should not be used for the 6K8 and 6K7, where these are used instead.

The circuit of the audio amplifier is one in which the application of negative feedback is made use of to supply tone control, by making the feedback selective with respect to frequency. Feedback is from the plate of the output tube to its own grid, via the CR network C_{11}, R_{14}. The former has the apparently very small value of 50 $\mu\mu$f., but this is correct, and not a mistake, as might well be imagined. It is the small size of this condenser which makes the feed-back change with the audio frequency being passed through the amplifier, with the result that when the moving arm of R_{16} is near the high-potential end of its movement, and the voltage fed back is greatest, there is much more feedback at high audio frequencies than at low audio frequencies. The audible result is thus, that the high frequencies are reduced in volume. The more the moving arm of R_{16} is moved towards earth, the smaller this effect is, because, as this is done, the amount of feedback at all frequencies is reduced, so that there can be less difference between the feedback, and therefore the response, at low and high audio frequencies.

Delayed A.V.C. is provided by the fact that the A.V.C. rectifier is connected with its load resistor returned to earth. The bias of approximately 6 volts developed across the cathode resistor of the EBL31 is therefore effectively a negative bias on the A.V.C. rectifier plate. As a result, the rectifier cannot conduct, and cannot therefore develop any A.V.C. bias for the controlled tubes, until the R.F. signal is greater than 6v. peak. Thus, the sensitivity of the set is greatest for very weak signals, and does not come into action until a reasonably strong one is tuned in. There is another useful effect of having a larger-than-usual A.V.C. delay voltage, and this is especially suited to the arrangement used here. It is that with a high delay voltage, the audio signal is allowed to build up to a higher level than when the delay voltage is low. This means that the signal from the detector is stronger, station for station, than in the average set, so that there is more signal available for swinging the grid of the power valve. This partially offsets the fact that there is less than the usual amount of audio amplification and therefore makes the absence of it less noticeable in practice.

It will be noticed that the magic-eye tube, an EM34, is operated, not from the A.V.C. line, but directly from the detector diode. The purpose of this is to ensure that weak signals will operate the eye, because if this were worked by the A.V.C. rectifier, no movement could occur until the signal was strong enough to overcome the A.V.C. delay voltage. Doing things this way makes it necessary to have an audio filter in the grid circuit of the EM34, in order to

(Continued on page 41.)

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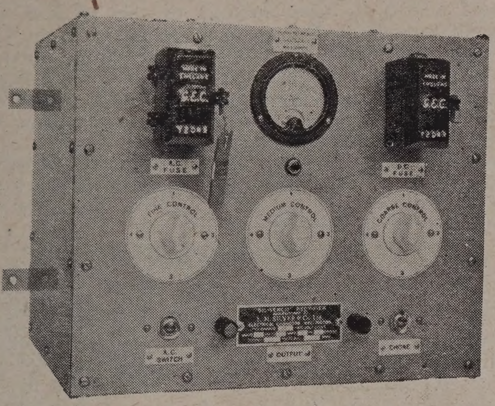

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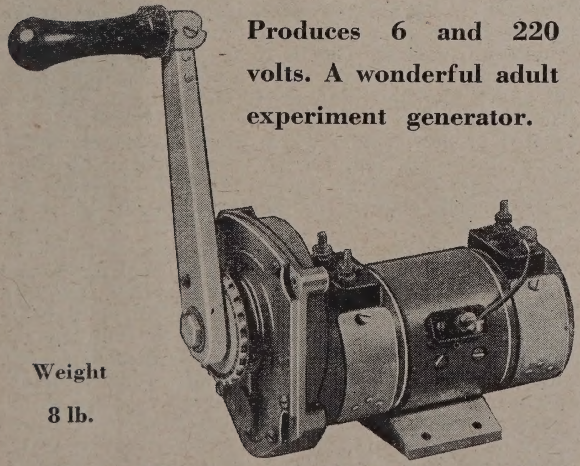

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CHANGING CIRCUIT VALUES FOR OTHER VALVE TYPES

If a 6K8 is used instead of the ECH35 as the oscillator-mixer, the greater screen current of the former will cause the screen voltage to be on the low side if the same circuit values are used. For this reason it is a good plan to change R_3 to 15k., 2 watts, which will give the correct screen voltage, and which will also ensure that the voltage divider is not overheated. It would also be advisable to reduce the cathode resistor to 250 ohms for the 6K8. The 6K7, if used in place of the EF39, can be substituted without any circuit alterations.

ALIGNMENT

The alignment of this set is exactly similar to that of any other set which has a mixer-oscillator and one stage of I.F. amplification. First of all, the I.F. trimmers are aligned. If one has a signal generator, this is simply a matter of feeding the 455 or 465 kc/sec. intermediate frequency into the grid of the mixer valve and "tweaking up" the trimmers, starting with the one nearest the second detector—i.e., the secondary of the second transformer, and working backwards until all are tuned for greatest volume, as judged by ear or on an output indicator. Those new to radio set construction need not despair because they have no signal generator, but instead can make a rough adjustment using a station received by the set. This can be done because most of the I.F. transformers sold for home-constructors are aligned in a circuit previous to being sold, so that if the settings are not disturbed during the construction, they will be fairly close to being correctly lined up after the wiring has been completed. In this case, all that needs to be done is to tune the set, with no aerial attached, until a station is heard. In all probability it will be on quite the wrong part of the dial, because the aerial and oscillator trimmers are not properly adjusted, but the I.F. amplifier does not mind this at all, and as long as some sort of signal can be tuned in; all will be well. With the station tuned in as well as possible with the tuning dial, the builder can now proceed to adjust the trimmers on the I.F. transformers, one at a time, until each is found to give maximum volume. That is to say, when one trimmer or tuning slug is being tuned, a position will be found at which the signal is loudest. The trimmer is left set at this position and the next is tried and also adjusted to the position which gives maximum output. After the whole four have been adjusted in this way, we can be reasonably sure that the I.F. circuits are well enough aligned for the front end of the set to be tackled.

Here, we have three adjustable condensers to be set. The aerial circuit has a trimmer condenser and the oscillator has a trimmer and a padder. The first step is to set the trimmers (labelled C_t on the diagram) to about three-quarters of their full capacity, as far as can be judged. The same is then done with the padder, C_p. Next, the dial is turned and a station as near as possible to the high-frequency end of the band is tuned in. If there is no station to be heard very near this end, which is where the condenser plates are nearly unmeshed, this does not matter. For example, in Wellington, 2YD is on 1120 kc/sec., and, although it is not very near the end of the band, it will do for the initial alignment. When the station

(Continued on page 41.)

An All-wave Low-noise Tuning Unit For a Converter or a Double Conversion Superhet Receiver

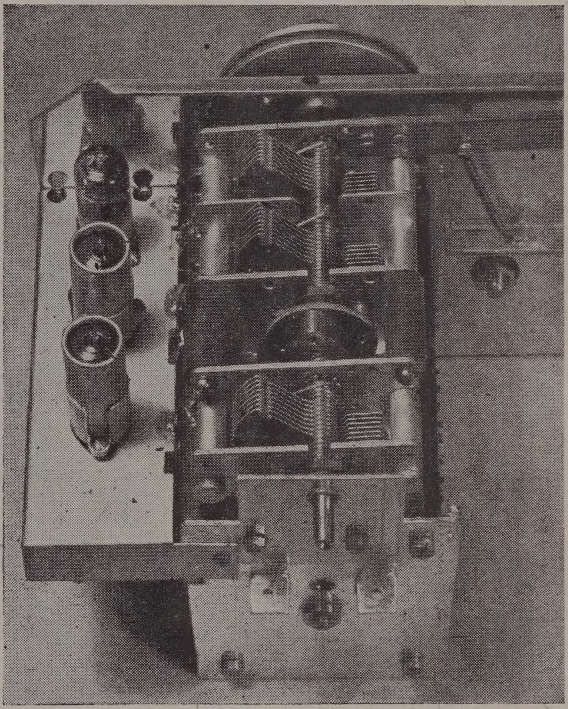
This article describes how an all-wave turret was built into a complete tuning unit by our laboratory. The constructional pointers given therein will be found helpful not only by those who have purchased this particular coil turret, but also by those who have ideas of constructing a turret themselves. The coil unit is designed for an I.F. of 1600 kc/sec., so that, by itself, it makes an admirable converter for operating with a good broadcast receiver, or the "front end" of a double-conversion superhet.

INTRODUCTION

Not once only, but many times, have we had occasion to remark that the communications receiver problem is a difficult one for the amateur designer and constructor to solve unaided. However, with some help from a manufacturer of coil units, the same problem becomes very much simplified, since there is nothing about a communications set, once the R.F. amplifier and first detector stages have been passed, which is not well within the scope of an experienced constructor. This is why, if any manufacturer comes out with an allwave coil unit that has any pretensions at all, there is always a rush to use it as the basis of a communications set.

Now, almost everyone would like a band-switched receiver, with a good deal of bandspread, either over the whole range, or else a very high degree of bandspread confined to certain small bands, such as the amateur transmitting bands, or the shortwave broadcast bands. Unfortunately, a coil unit answering to this description and covering a range of frequencies up to 30 mc/sec. is a job that everyone would rather see done by someone else rather than do himself! The question of what is the best type of construction for a band-switching unit is one upon which considerable debate is possible, but the method of mounting all coils in a movable turret is now recognized as perhaps the best solution, albeit a somewhat expensive one. The great advantage of the turret over fixed coils and a wave-change switch is that the former enables the leads to be made the same length on all bands, with the result that there is little if any loss of efficiency on the higher frequencies. The turret arrangement also makes it possible for the leads carrying R.F. to be made shorter than is the case with any other method of coil mounting, and also makes it a very simple matter to short-circuit unused coils, and to ground certain connections to them, thereby preventing those coils that are not in use from having any effect on those that are in use at any particular moment. As against these undoubted advantages, the turret method of construction necessitates some excellent mechanical work, which is outside the capabilities of many builders, and tends to discredit the method among amateur constructors. However, when a well-constructed commercial turret is available, and at a reasonable price, this objection disappears.

The turret with which this article is concerned was advertised in these pages some time ago, and at the moment, to the best of our knowledge, is not available at present, but a number of them have been sold, and, for the sake of other constructors, it is to be hoped that more will become available in the future. No doubt, Mr. Nash will have the deciding say about this!



Top view of the turret, showing the valve panel. From the rear, the valves are oscillator, mixer and R.F. amplifier.

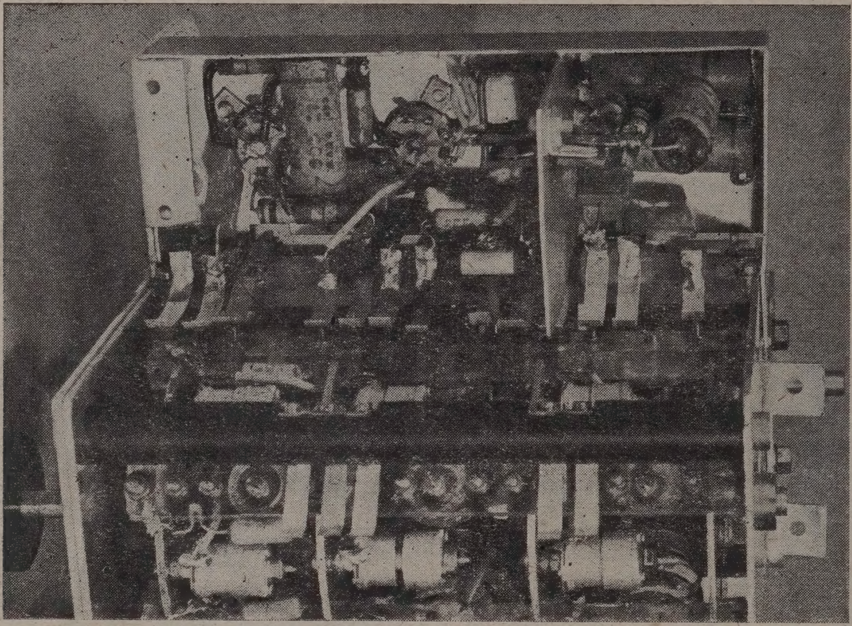
SPECIFICATION OF THE TURRET

The turret is designed for one stage of R.F. amplification, oscillator, and mixer, with an output frequency of 1600 kc/sec. There are six bands, covering from 200 kc/sec. to 36 mc/sec. The bands are—

(1) 200 to 500 kc/sec.
(2) 550 to 1500 kc/sec.
(3) 1.65 to 4.8 mc/sec.
(4) 4.8 to 9.5 mc/sec.
(5) 9.5 to 18 mc/sec.
(6) 18 to 36 mc/sec.

These ranges are calibrated on the main dial. There is also a bandspread arrangement which, while mechanical in action, gives very smooth tuning, and is also arranged to give complete and calibrated bandspread over all amateur transmitting bands. This system works on the following ingenious manner. The tuning condensers are mounted so that the whole gang floats on a pair of bearings, one at each end.

It is thus possible to move the stators as well as the rotors. The latter can be moved over their full 180 degrees travel, in the usual way, while the stators are moved over only 25deg. or so. This movement is accomplished by having a long brass arm attached to the stators. At the end of the arm is a pin which is constrained by a coil spring to bear on the surface of a cam. The latter is driven by the bandspread dial, and is shaped so that the latter turns through about 340 deg. in the process of turning the stators of the gang through only 25 deg. The shape of the cam also allows the calibration of the bandspread dial to have a straight-line-frequency law on all spread bands.



This system works very well in practice, without any backlash, and without the alignment troubles inherent in purely electrical methods. In operation, the main dial is set to a particular frequency, whereupon the appropriate spread band can be read directly from the calibration on the bandspread dial. The latter also has a logging scale marked 0 to 340, and this can be used for logging stations on the shortwave broadcast bands, for which the bandspread dial has no direct calibration.

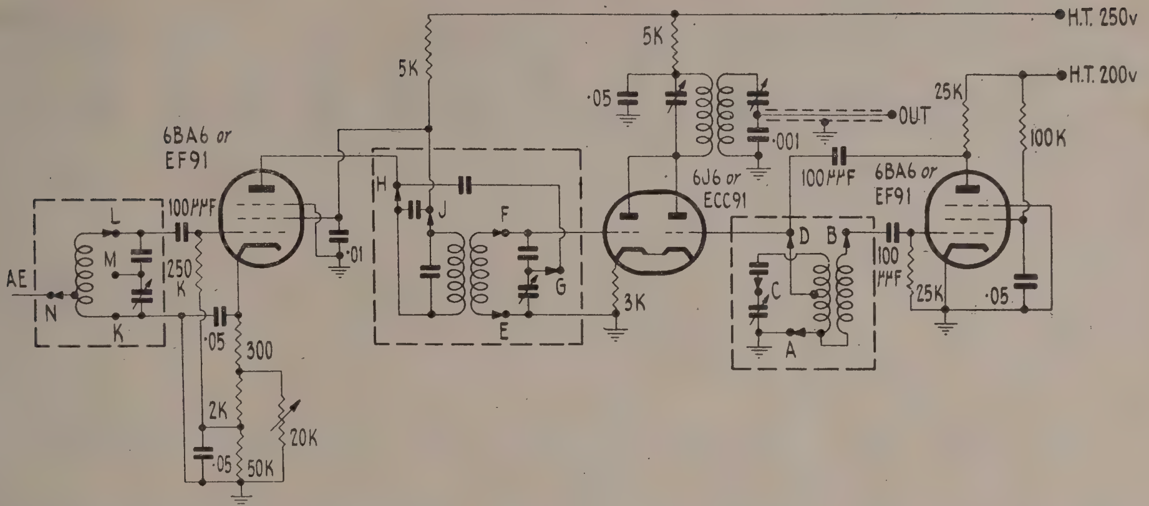
THE CIRCUIT

The circuit diagram does not really give any idea of the small amount of work required to build the turret into a complete "front end" unit, since it shows the circuits that are included in the turret as well. Those portions of the circuit that are enclosed within the dotted squares are actually those provided in the turret, so that all that has to be provided by the constructor are the components outside these dotted lines.

The R.F. amplifier uses an EF91 or a 6BA6, both of which are miniature R.F. pentodes, which will work well up to very high frequencies. At this stage it should be mentioned that the letters marking the arrows represent the contacts which come out at the side of the turret, and to which all connections are to be made. The actual letters used correspond with those on the manufacturer's data sheet. It will be seen that not all of them are used by the constructor. For instance, E and F connect the mixer grid coil to the tuning condenser, with its series condenser, and no connections go from either of them to the external circuit. The latter is connected to G. E, of course, is earthed, as the diagram shows.

It will also be noticed that a somewhat unusual gain control circuit has been used in the R.F. stage. This is due to the fact that the EF91, which is the type recommended by the manufacturer, is not, properly speaking, a remote cut-off tube at all. As a result, the only practicable way of controlling its gain, while allowing it to handle large signals without undue distortion owing to grid circuit overloading, is to control both suppressor and control grids simultaneously. At first sight it might not appear that the suppressor is controlled at all with this circuit, but a little reflection will show that this is indeed not the case. The suppressor is connected, not to the cathode, as is usual, but directly to earth. As a result, any positive potential developed at the cathode causes the suppressor to be at a negative potential with respect to the cathode, and therefore to be controlled. The grid is returned neither to the cathode (in which case it would not be controlled, however positive the latter were made) nor to earth, but to a point at some intermediate potential, much nearer to the cathode potential than to earth. This means that, in effect, a small portion only of the cathode-earth potential is applied to the control grid. The ratio of the control voltages applied to the suppressor and the control grid is determined by the voltage divider consisting of the 300-ohm minimum bias resistor, and the 2k. and 90k. series combination, in parallel with the 20k. gain control rheostat.

This circuit will also be quite satisfactory if the



6BA6 is used, but with this valve it may be simplified to the more usual arrangement of a simple variable cathode resistor, the suppressor being returned to cathode in the normal way.

The mixer circuit is the same one that was recently described in these pages, and which was also used in the "Junior Communications Receiver." It is a low-noise circuit, which, unlike the so-called infinite-impedance mixer, has considerable conversion gain at the same time as possessing excellent low-noise characteristics. It also possesses the virtue of extreme simplicity. The mixer plate transformer is a conventional 1600 kc/sec. I.F. transformer, with one slight modification. This is to be found on the secondary side, and makes an excellent low-impedance output connection, which is suitable either for feeding into the aerial terminal of a receiver or for coupling into a specially constructed I.F. channel, whether on a separate chassis or not. The modification consists solely of disconnecting the earthy end of the secondary's trimming condenser and connecting in series with it a 0.001 μf. condenser. The junction of the two is used as the output terminal for the unit. The 0.001 μf. condenser is so large in value compared with the trimmer that it has a negligible effect on the tuning of the secondary, and there need be no fear that it will no longer hit resonance. The value of the condenser is not at all critical, so that the capacity to ground of the shielded output lead can be as high as we wish, without having any deleterious effect on the performance. This capacity simply adds a little to the capacity which is in series with the trimmer, and once the length of lead has been decided upon, and is installed, the secondary trimmer can be peaked up and forgotten, with full knowledge that no noticeable de-tuning can be caused by any connection that might be made to the far end of the output line. Also, since the transfer of signal takes place at a low impedance-level, the voltage concerned is also low, so that dielectric losses in the shielded cable can also be expected to be small. Of course, if the remainder of the I.F. circuits are to be placed on the same chassis as the tuning unit, the low-impedance output coupling will not be essential, since the 1600 kc/sec. I.F. amplifier, or the second mixer, can be placed next to the transformer in the usual way. However, if lay-out considerations make it necessary to place the next valve, whether amplifier or frequency converter, at a distance from the first mixer, the low-impedance coupling can be used with advantage. The transformer is mounted as close as possible to the 6J6 or ECC91 first mixer, and the system illustrated in the circuit diagram used to allow the employment of a long shielded lead, just as if the next valve were on a separate chassis. Then, in order to step up the impedance again, for the following grid current, the same trick is done, but on the **primary** of a second transformer. The large condenser is given the same value, namely, 0.001 μf., and the secondary is used in the grid circuit of the next valve in the ordinary way.

The oscillator circuit uses a second EF91 or 6BA6, pentode connected, and in a plate-tuned arrangement. The reason for this is that the coils of the turret are specially suited to this type of oscillator circuit, and by using this one we are simply adhering to the manufacturer's recommendation. Here, it should be mentioned that the oscillator coils have resistors shunted across them, in an attempt to flatten the amplitude characteristic of the oscillator, over each band. Under some circumstances, it is recommended that these be removed, and in our case this was done, simply by cutting through one of the connections of each with a pair of side-cutters. There is no need to remove the resistors physically from the turret.

CONSTRUCTION

By far the best way of constructing the circuit is to make a small sub-chassis for the three valves. This is attached to the framework of the turret unit, and makes a completely wired unit, which itself can be slipped in and out of a main chassis without at all disturbing the wiring of the circuit, except for disconnecting the input, output, and power leads. Fig. 1 is a working drawing for the small sub-chassis, and Fig. 2 is the small cross-socket shield for the R.F. valve. The photographs show the sub-chassis, complete with valves and wired up, as it appears when attached to the turret. In the top view, two holes can be seen at the end nearest the front panel. The purpose of these is to give access to the mounting holes for the turret itself, which otherwise would be covered up.

(Concluded on page 48.)

A 6-watt Transmitter or Exciter for the 2-metre Amateur Band

In last month's issue of "Radio and Electroni cs," we published the description of a push-pull 8012 Class C amplifier stage for 144 mc/sec. This month, we are following up with a circuit which makes an admirable low-powered tra nsmitter for this band, or which can be used to drive the 8012 amplifier to outputs in the region of 40 watts.

INTRODUCTION

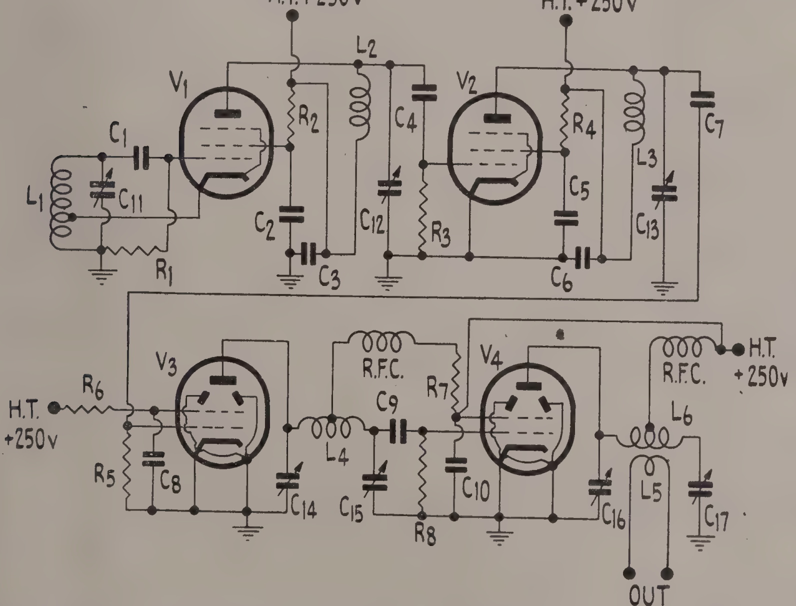
To some of our readers, it may have looked rather like putting the cart before the horse to describe a more or less high-powered final amplifier for the 144 mc/sec. band without previously having shown how to get enough power to drive it to its fullest capabilities. In so far as many amateurs are capable of building a simple self-excited oscillator on this frequency for themselves, thus making an excellent medium-powered M.O.P.A. transmitter, this is not quite true, but at any rate, we are taking an early opportunity of showing how an excellent low-powered transmitter or exciter can be built for a band which is becoming more and more popular as time goes on.

Since the 144 mc/sec. band **is** increasing in popularity, and therefore in occupancy, it is only right that intending operators should think more in terms of frequency stability and less of simply hitching up something self-excited that will make some sort of hole in the ether, whether obnoxious to others or otherwise. In short, 144 is going the same way as all bands have done, progressively, ever since there was amateur radio—namely, towards good frequency stability and the best possible use of the space available.

TO CRYSTAL OR NOT TO CRYSTAL

At one time, and to some extent to-day, the mere mention of frequency-stability conjured up thoughts of crystal control, this being the absolutely last word, but in these enlightened times we know a little more about the operation of stable self-excited oscillators, and many prefer them to crystals, particularly for amateur work, where no dire penalties accrue if accidental frequency shifts occur through such things as unintentional shifting of the master oscillator tuning control. Thus, in designing the accompanying circuit, we have catered for all tastes except that of the crystal-at-all-costs school of thought.

The next best thing to a transmitter consisting solely of a self-excited power oscillator is a simple M.O.P.A. outfit, with a self-excited low-power oscillator driving a straight amplifier on the signal frequency, but in these days it is recognized that such an improvement, from the stability point of view, is not so very much better than the modulated oscillator. The reason is, of course, that, although the Class C amplifier represents a comparatively stable load on the oscillator, adjustments of the amplifier still affect the oscillator frequency to a noticeable extent, so that, under modulation, a certain amount of frequency modulation still occurs. Now for space-conservation on the band, the slightest amount of unintentional F.M. is to be deplored, if it can be avoided. For this reason, neither we nor many others besides look with much favour on the simple M.O.P.A. We have therefore decided to go, if not quite the whole hog, at least a portion of this estimable animal, and place a string of frequency multipliers between our oscillator and the output amplifier. There are, in fact, two frequency multipliers, both



COMPONENT LIST

R_1, R_3, R_8, 50k. 1 watt.
R_2, R_4, R_6, 25k. 2 watt.
R_7, 2k. 1 watt.
C_1, 50 $\mu\mu$f.
C_2, 0.02 μf.
C_3, C_6, C_{10}, C_8, 0.002 μf.
C_4, C_7, C_9, 25 $\mu\mu$f. silvered mica.
C_5, 0.01 μf. paper, in parallel with 0.0001 mica.
C_{11}, 25 $\mu\mu$f. silvered mica, in parallel with a 20 or 30 $\mu\mu$f. max. variable.
C_{12}, C_{13}, C_{15}, C_{17}, 20 $\mu\mu$f. max. variable.
C_{14}, C_{16}, 3-30 $\mu\mu$f. Philips trimmer.
V_1, 6F6 or 6V6.
V_2, 6V6.
V_3, V_4, QEO4/10 or QVO4/7.

doublers, between the oscillator and the output stage. The latter is a "straight" amplifier, and with only 250 volts on plate and screen, produces a good 6 watts on the 2-metre band. This is enough for a good hearty signal on its own account, and enough also to put a matter of 15 to 20 ma. of grid current into the pair of 8012's should it be desired to use them as a high-powered final amplifier.

The oscillator itself, as can be seen from a glance at the circuit diagram, is an E.C.O., which itself doubles in its plate circuit, making a total frequency multiplication of eight times. This places the fundamental oscillation frequency at 18 to 18.5 mc/sec. to cover the whole band from 144 to 148 mc/sec.

In bringing in an E.C.O. and two further multiplier stages, we have removed oscillator loading effects completely, and at the same time brought the fundamental oscillation frequency low enough for excellent stability to be attained. There is thus no good reason why the frequency stability should not be as good as that of a crystal-controlled transmitter. In fact, the set-up has all the advantages of crystal control, with the additional one that the frequency can be changed within the confines of the band with a maximum of speed.

CIRCUIT DETAILS

The oscillator can be either a 6F6 or a 6V6, and uses a conventional electron-coupled circuit. The plate circuit is tuned to 36 mc/sec., is series fed, and capacity-coupled to the grid of the first doubler. This is a 6V6, and is similarly tuned, and coupled to the second doubler. Its plate circuit is, of course, tuned to 72 mc/sec. So far, the valves and circuits are quite ordinary, and require no special comment, but since we have reached a fairly high frequency, it is found that conventional doubler circuits are not quite adequate to cope. The main reasons for this are that already we are past the recommended frequency limit for ordinary receiving valves, and that the stray capacities are now so great in relation to the working frequency that it is advisable to resort to special circuits if we are to obtain the best results.

VALVES FOR THE FINAL DOUBLER AND STRAIGHT AMPLIFIER

Having arrived at 72 mc/sec., and found that the 6V6 can give enough power output with only 250 volts on the plate, to excite a further tetrode or pentode multiplier stage, the main difficulty is to choose a suitable valve. If we try another 6V6, or similar receiving tube, the chances are that the efficiency will be so low that if we do not exceed the plate dissipation rating, the power output on 144 mc/sec. will be negligible. The ideal solution would thus appear to be to use a small tetrode or pentode, specially designed for transmitting application at frequencies up to 150 mc/sec., and, if necessary, to run it light, so that the total H.T. drain of the multipliers is not too high for reasonable economy. Fortunately, although such a valve is not available from the American catalogues, there is available an English or Continental tube which fits the above specification admirably. It is known under two type numbers, QVO4/7 and QEO4/10, and if dealers do not happen to have stocks of one or other of these types, they should be able to obtain them quite readily. There is no differ-

(Continued on page 33.)

The amazing new

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"Magic Ribbon" Recorder

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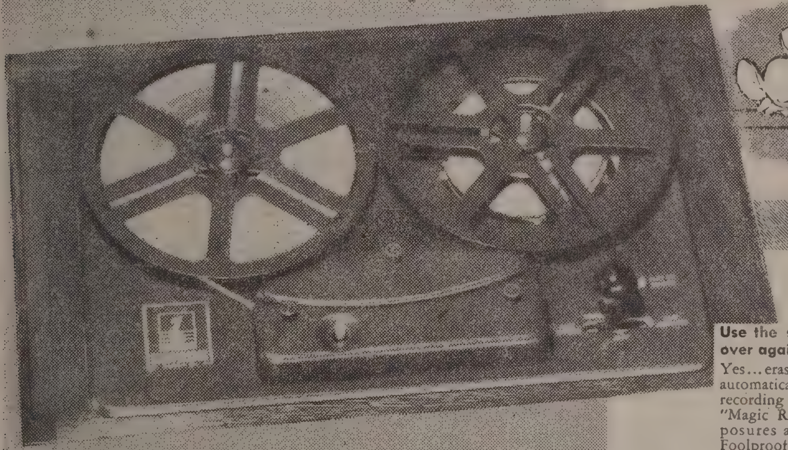
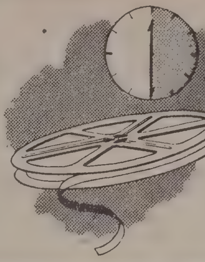


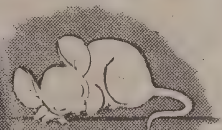
Long experience in magnetic recording has demonstrated that the use of a simple heavy duty motor has overcome certain adverse features of the 3 motor drive incorporated in the pioneer models.

Note "Joystick" mechanical control which eliminates electrical switching with its inherent disadvantages.

Full . . . unbroken half hour recording on every reel of "Magic Ribbon!"
Now you can record any program exactly as your radio receives it! . . . You can enjoy *uninterrupted* recordings of your favorite symphonies . . . entire operatic scores . . . or the popular tunes of the nation's best bands.



You can cut, edit, and splice "Magic Ribbon" together with just scissors and cellulose tape!
It's a simple matter to cut out the unwanted parts of any program. It is equally simple to join several recordings together and put on one reel the music of one particular orchestra.



Quiet . . . no needle scratch, no surface noise!
Whatever you record on the amazing "Magic Ribbon" replays with lifelike fidelity.

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Yes . . . erasures are accomplished automatically whenever a new recording is made on a reel of "Magic Ribbon". . . double exposures are thus impossible. Foolproof controls prevent accidental erasures.

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DESIGN SHEET No. 6

PHASE-SHIFT OSCILLATORS FOR FREQUENCIES UP TO 100 kc/sec.

Often there is a requirement for an audio oscillator which can be built up in temporary form for a special job, such as testing a newly-built amplifier or modulator, especially when the amount of such work that is done is insufficient to warrant the outlay in time and material necessary for building a permanent audio oscillator. The single-valve phase-shift oscillator is ideal for this purpose, for, as Fig. 1 shows, the circuit is exceedingly simple and requires a minimum of parts. If required, it could be put together from the "junk box" in half an hour, and its power supply requirements are so light that it can be tacked on to anything that may be at hand—even a receiver, or some batteries. It consists of a simple pentode resistance-coupled amplifier, in which the output is fed back to the input through a resistance-capacity network. Briefly, the principle of operation depends on the fact that such a network has one frequency, and one frequency only, at which the phase shift through it is zero. This being the case, the feedback is greatest at this frequency and less at all other frequencies, with the result that the circuit oscillates at the frequency of zero phase shift.

CONDITIONS UNDER WHICH IT WILL WORK

It can be shown by a mathematical analysis of the circuit that as long as R_1 is very much greater than any of the resistors R, the attenuation through the network at the frequency of the zero phase shift is 29 times. Thus, subject to the condition that R_1 is very much greater than R, the circuit will oscillate as long as the amplification in the valve at the required freqency is equal to or greater than 29 times. The more nearly the value of R approaches that of R_1, the greater will be the valve gain needed to cause oscillation.

A formula has been worked out which relates the gain needed in the amplifier to the values of R_1 and R. It is—

$$A = 29 + 23\left(\frac{R_1}{R}\right) + 4\left(\frac{R_1}{R}\right)^2$$

If R is very much greater than R_1, then both the right-hand terms of this equation become negligibly small, and $A = 29$, as stated above. If R is equal to R_1, then the equation reduces to—

$$A = 29 + 23 + 4 = 56 \text{ times}$$

Now, at low audio frequencies, it is a very simple matter to realize a voltage gain of more than 56 times in a single resistance-coupled pentode stage, and suitable values of R_1, R_2, and gain can be found in the valve manufacturers' tables. The only difficulty that is likely to occur is in reaching the higher frequencies. For example, should it be desired to make the oscillator go at 100 kc/sec., for some special purpose, it will be necessary to ensure that the gain is great enough at this frequency. However, there should never be any great difficulty in securing oscillation at almost any desired frequency, because there is a large range of values over which R can be varied. This will be dealt with under the next heading.

OSCILLATOR FREQUENCY

There has also been developed a simple formula by means of which the oscillation frequency can be predicted, if the constants are known, or which will enable the values of C and R to be chosen to give a particular frequency. It is—

$$f = \frac{1}{2\pi\sqrt{6}\,RC}$$

In order to save working out this formula, the design chart has been prepared in the form of an abac, which will enable a very quick answer to be obtained. Actually, there are two abacs, each covering a different range of R and C values. The right-hand one is more suitable when it is desired to use three ganged variable condensers for C, in order to make the frequency adjustable. The left-hand one is more suitable where larger, fixed condensers are intended to be used for fixed frequency working. It can be seen, both from the formula and the charts, that to get any particular oscillation frequency, there are a vast number of possible combinations of C and R that can be used. Theoretically, of course, the choice is infinite, but in practice we are limited by the requirement that R should be much greater than R_1.

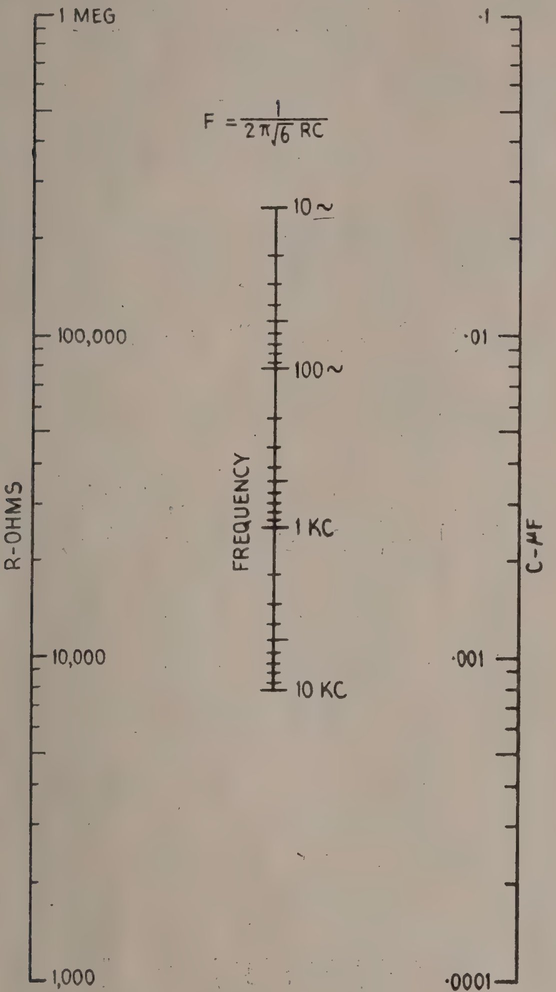
METHOD OF CHOOSING VALUES

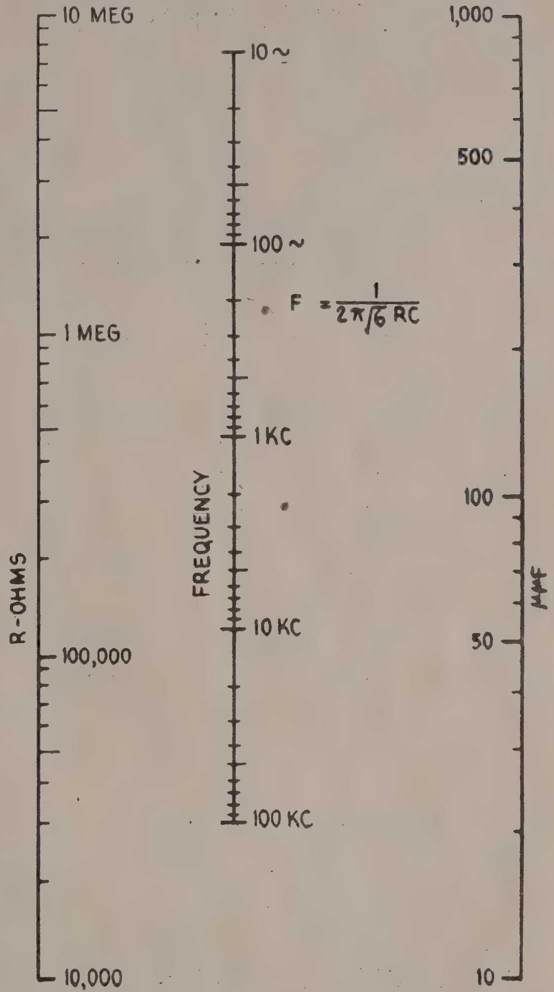
It might seem that the charts are therefore very little use, but if the following procedure is adopted, it will be seen that they are of great value. First, the valve to be used is chosen. Next, a value of R_1 is chosen, either on general principles, or from the valve books. These also give suitable values for R_2, which is not of any great concern, so long as the screen is worked at a suitable potential. Having chosen R_1 and having found from the valve books that this gives a gain considerably greater than 29 times, we are in a position to choose R. This can be done by referring to the first formula, which enables the required amplification, A, to be found for any value of R_1/R. We now have a value for R_1, and a value for R_1/R, so that a value for R can be worked out. Now, the value so arrived at is the SMALLEST value of R that will allow oscillation to take place, assuming that the valve gain is as the book states, and that the value of R_1 is used, as chosen. Thus, to be on the safe side, it is good practice to allow a factor of safety of at least 2, and to fix R at twice the worked-out value. Then, this value is used in conjunction with the abac to find the required value for C, and the job is completed.

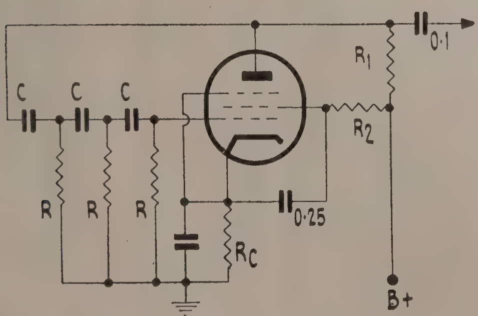
SOME FURTHER POINTS

There are still one or two points about which readers will no doubt wish to be informed. One is, how, if at all, can it be seen that the output waveform is as nearly sinusoidal as possible? The second is, if the frequency is wanted to be accurately set to a given value, how can this be done? A third point is, what is wrong if, after the design procedure has been followed, the circuit does not oscillate? Let us take these points in order.

After the circuit has been set up and found to oscillate, it may be found that the waveform is anything but good and does not resemble a sine-wave very much at all. If this is the case, it simply means that the valve is oscillating too fiercely, and that if something is done to cut down the strength of the oscillation, the waveform will improve. A good method of doing this is to make the cathode resistor variable. As the value is increased, the mutual conductance of the valve is decreased, and the amplifica-







Circuit of the oscillator to which the Design Sheet refers. The chart is not applicable to any other circuit.

tion with it. If this decrease is taken to the point where the circuit just oscillates and no more, then the waveform will be very nearly a pure sine-wave. Thus a variable cathode resistor can be used as a waveform control. A suggested value is 2000 to 5000 ohms, which will usually be found enough to stop oscillation, and therefore to set the circuit to just-oscillating condition. If desired, a minimum bias resistor can be used in series with the rheostat to ensure that when the circuit is oscillating at its hardest the waveform is not too bad.

The second point, that of making slight adjustments to the frequency, is easily covered by making a portion of one of the R's variable. If preferred, one of the C's can be made adjustable instead, and this will not upset the R values to any extent.

AN EXAMPLE OF SUITABLE DESIGN

To assist readers, we will finish up with a specimen design, which will be useful in itself and will show how the scheme works.

Suppose we have a 6SJ7 available, and wish to

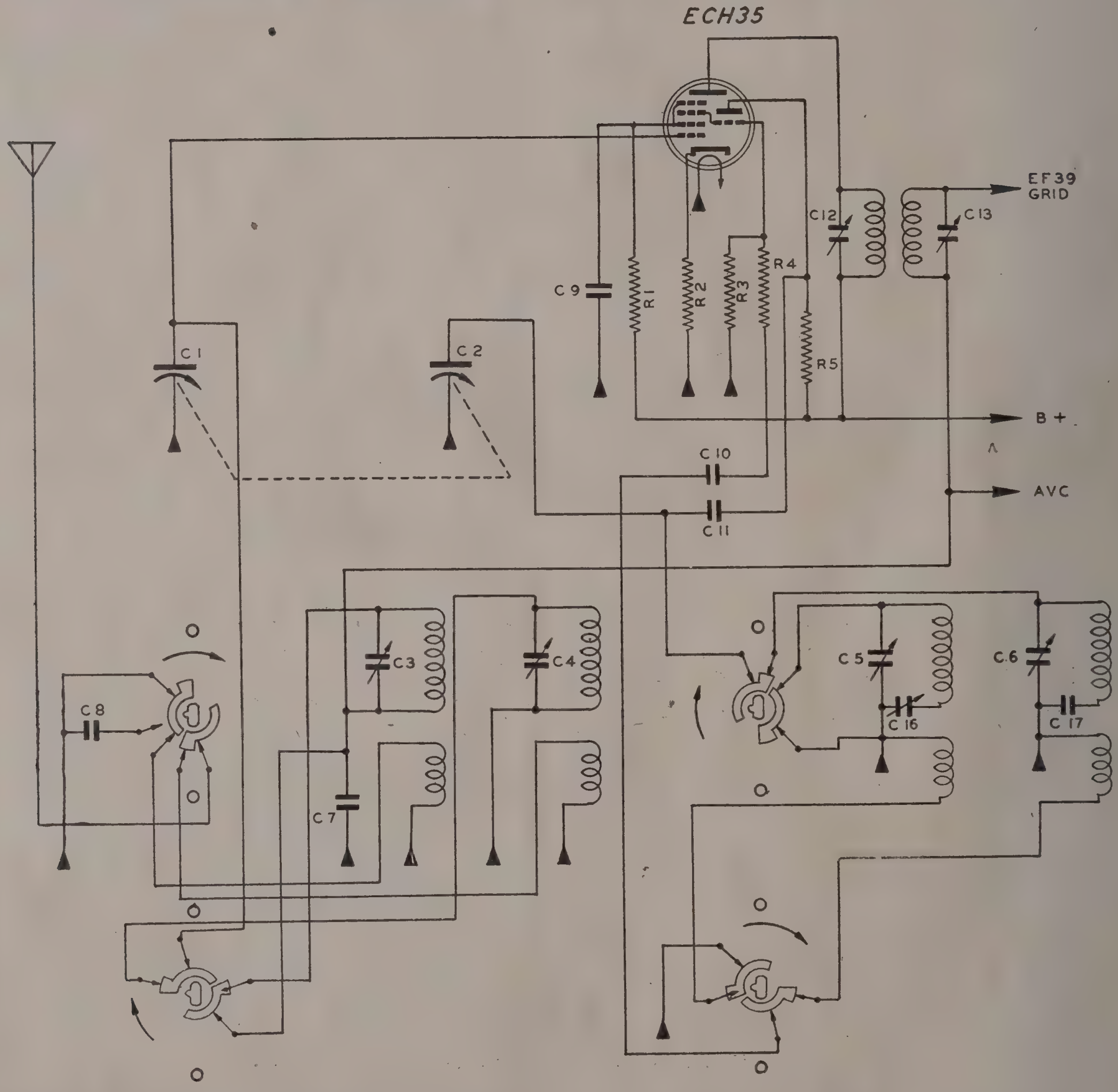
(Concluded on page 44.)

For The Serviceman

We have pleasure in commencing a new series of circuits and alignment data for late-model commercial receivers. We are indebted to the manufacturers for the material presented in these pages, and wish to thank them on behalf of ourselves and our readers, who found the last series of circuits so useful.

Where possible, we are printing advertisements on the reverse sides of the sheets so that readers may take them out of the journal without damaging any other reading matter.

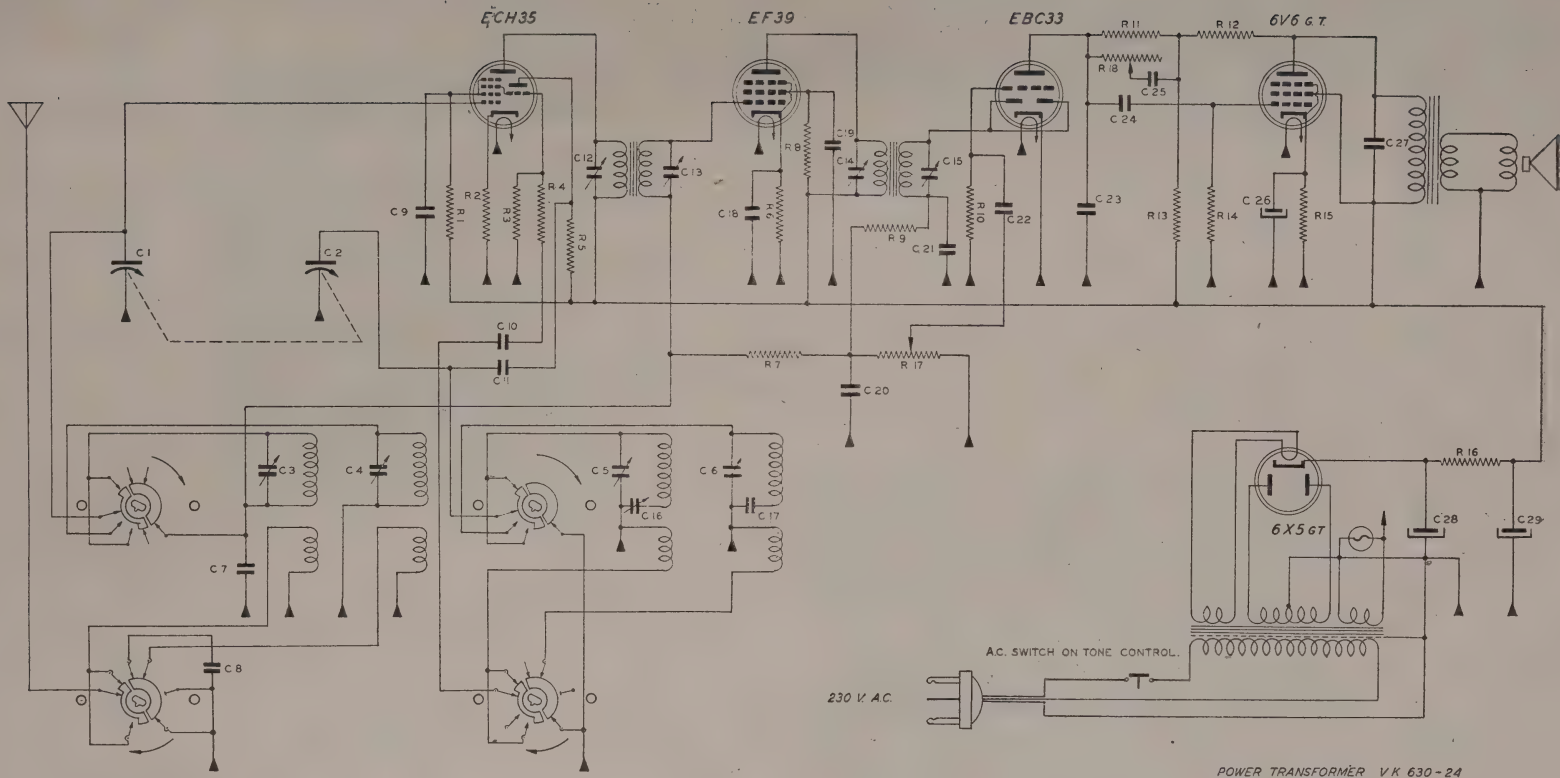
PHILIPS RADIOPLAYER MODEL 648



WAVE CHANGE SWITCH SHOWN IN POSITION #1 — SHORTWAVE.
POSITION #2 — BROADCAST
POSITION #3 — LOCAL BROADCAST.

SHOWING DETAILS OF WAVE CHANGE SWITCH USED IN EARLY PRODUCTION ONLY.
FOR COMPONENT VALUES ETC, REFER TO SHEET #1

SHEET # 2.



WAVE CHANGE SWITCH SHOWN IN POSITION # 1 — BROADCAST.
POSITION # 2 — LOCAL BROADCAST.
POSITION # 3 — SHORTWAVE

POWER TRANSFORMER VK 630-24
PRIMARY RESISTANCE — 54 Ω
SECONDARY RESISTANCE — 155 Ω + 155 Ω

OUTPUT TRANSFORMER VK 670-09
PRIMARY RESISTANCE — 410 Ω

I.F. -455 K.C.

SHEET # 1

CONDENSER AND RESISTOR VALUES

COIL CONNECTIONS

AERIAL COIL — VK 469-35

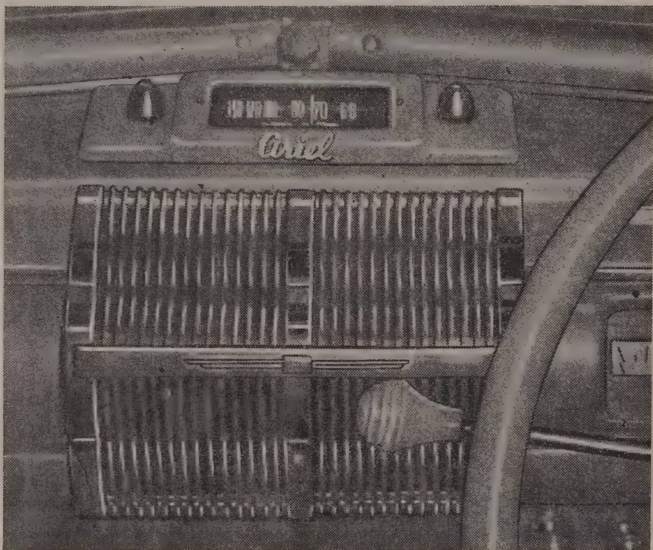
	LIVE	COLD
B.C. RRI. —	7	6
S.W. PRI. —	8	6
B.C. SEC. —	2	4
S.W. SEC. —	1	5

OSCILLATOR COIL — VK 471-17

	LIVE	COLD
B.C. GRID —	3	6
S.W. GRID —	2	6
B.C. PLATE —	8	7
S.W. PLATE —	1	4

C_1, C_2, 14-542 μμf. tuning gang.
C_3, C_4, C_5, C_6, 3-30 μμf. trimmer.
C_7, .05 400v. paper.
C_8, C_9, .01 400v. paper.
C_{10}, C_{11}, 100 μμf. ceramic.
C_{12}, C_{13}, C_{14}, C_{15}, I.F. trimmer
C_{16}, 450-600 μμf. padder.
C_{17}, .006 μf. mica.
C_{18}, .05 400v. mica.
C_{19}, .01 600v. paper.
C_{20}, C_{21}, 100 μμf. ceramic.
C_{22}, .02 μf. paper.
C_{23}, 250 μμf. mica.
C_{24}, .05 μf. 400v. paper.
C_{25}, .004 μf. 400v. paper.
C_{26}, 25 μf. 25v. electrolytic.
C_{27}, .005 μf. mica.
C_{28}, C_{29}, 50 μf. 400v. electrolytic.
R_1, R_3, R_9, 50,000 ohms ½ watt.
R_2, 50 ohms ⅓ watt.
R_4, R_6, 200 ohms ½ watt.
R_5, 25,000 ohms ½ watt.
R_7, 2 megohms ½ watt.
R_8, R_{12}, 68,000 ohms ½ watt.
R_{10}, R_{14}, .5 megohms ½ watt.
R_{11}, 100,000 ohms, ½ watt.
R_{13}, 10,000 ohms ½ watt.
R_{14}, .5 megohms ½ watt.
R_{15}, 600 ohms 1 watt.
R_{16}, 1,500 ohms 2.5 watts.
R_{17}, .5 megohms volume control.
R_{18}, .5 megohms, tone control.

'ARIEL' car radio



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1946-1947-1948 Models

NO SUPPRESSORS ARE USED NOR IS THE ELECTRIC SYSTEM OF THE CAR INTERFERED WITH IN ANY WAY.

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Obstructions round the feet of driver and passengers are entirely eliminated. Great care has been taken with the circuit design to achieve maximum sensitivity and freedom from ignition interference.

Distant stations are received in full daylight without any trace of engine noise.

The handsome moulded sheet-plastic dial escutcheon takes the place of the clipped-in cover on the instrument panel. The dial is tilted for good vision from the driving position.

It harmonizes with the interior of the car. The heavy-duty 8 in. speaker, projpecting its sound through the chromium grille from directly in front of the listener, provides volume and tone better than that of the average standard domestic radio.

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The "Radio and Electronics" Abstract Service

AUDIO EQUIPMENT AND DESIGN:

The LP Microgroove Record System. A consideration of the characteristics of long-playing records: pick-ups and motors required and changes in receivers necessary when two types of commercial (U.S.) adapters used.

—Service (U.S.A.), November, 1948, p. 14.

Three-tube Dynamic Noise Suppressor. Circuit and details of a unit of simplified design manufactured in U.S.A. Response curve illustrated.—**Service (U.S.A.), November, 1948, p. 26.**

Negative Feed-back Amplifiers. If feed-back applied to amplifiers of two or more stages is increased beyond certain small amount, the frequency characteristic develops peaks at the edges of the band, leading, with further increases, to self-oscillation. Mathematical analysis to show that substantially flat response over wide frequency band is possible with any amount of feed-back if gain properly distributed over the stages.—**Wireless Engineer (Eng.), February, 1949, p. 43.**

ANTENNAE AND TRANSMISSION LINES:

Aerial Corona Interference. Discussion of matter of interference experienced from corona effect in cases where vertical rod-type of aerials used for broadcast and television reception. Outline of steps to be taken to eliminate such interference.

—Wireless World (Eng.), December, 1948, p. 441.

A "Plumber's Delight" Rotary Beam for 14 mc. Various practical designs for rotary beam antennae and helpful suggestions for intending constructor.

QST (U.S.A.), February, 1949, p. 18.

CIRCUITS AND CIRCUIT ELEMENTS:

A Note on Interstage Coupling for D.C. Amplifiers. Reference to disadvantage of high positive potential with respect to earth existing in output stage of cascaded multi-stage amplifiers (D.C.). Circuit drawn in which use made of a high-impedance pentode valve as a coupling agent between later stages. Pentode replaces one of the resistors in a potential divider normally consisting of two resistors in series, with negative bias, used to couple two D.C. amplifiers.

—Electronic Engineering (Eng.), February, 1949, p. 61.

Circuit Symbols. Notes on the new British Standard appearing in a revision of "Graphical Symbols for Telecommunications" (B.S. 530: British Standards Institution, 28 Victoria Street, London, S.W.1; 10s. 6d., post free).

—Wireless World (Eng.), December, 1948, p. 437.

Electronic Circuitry. (a) Beam switches. Circuit of a cathode-coupled p.p. gate. Also described is a high-speed gate circuit using a 6J6 valve and an EF91 to make a beam switch, with a switching frequency of 100 kc/s. (b) Direct-coupled amplification for photocells. A cathode-follower circuit giving freedom from instability, though with limited speed of response.

—Wireless World (Eng.), December, 1948, p. 444.

The See-Saw Circuit Again. Applications as a stable wide-band voltage amplifier. Circuits for audio frequencies, for frequencies above audio range (the T circuit), and a direct-coupled see-saw where response down to zero frequency is desired.

—Wireless World (Eng.), December, 1948, p. 447.

Stabilized Power Supplies: III. Extension of output voltage range. Circuits of a stabilized power supply with variable output range from 0-500 volts. Discussion of methods of gaining such extended range, and reference to points requiring careful treatment. Appendix has mathematical analysis of principle of operation.—**Wireless World (Eng.), December, 1948, p. 453.**

Low Impedance Variable Voltage Tappings. Using the cathode-follower as a D.C. potential divider. The Mullard EC52 (triode) valve is chosen, its Ia/Va characteristics used to illustrate properties and design of "electronic tapping" method. From characteristics is derived a regulation curve. Operation of the circuit analysed. Enumeration of other suitable types of valve and consideration of special modifications of the circuit. A second circuit is drawn for the provision of heavy current at a higher output voltage: employs auxiliary cathode-follower and neon tube to maintain constant screen voltage to type of valve used.—**Wireless World (Eng.), January, 1949, p. 2.**

Economical 50-watt Amplifier. Taking advantage of new ratings for KT66 type of valve (permissible maxima of 400 volts and 500 volts for screen and anode respectively), a circuit is given for an amplifier using these valves in push-pull, transformer coupled to preceding low impedance triode stage. Performance curves drawn.

—Wireless World (Eng.), December, 1948, p. 457.

Versatile Power Supply. For light-current work. Main supply in three steps of 150 volts each, with four selenium rectifiers. Fourth 150-volt transformer secondary winding is used with a potentiometer to give voltage regulation. The potentiometer is connected in series with the other secondary windings. Two additional outputs are provided, giving screen supply of 100 volts or 200 volts, and a bias supply of 25 or 50 volts, respectively. Details of construction and assembly.

—Wireless World (Eng.), January, 1949, p. 21.

Electronic Circuitry. (1) Interval timers. A combined trigger and charging circuit and (b) transformerless phase-shifter for use when it is desired to phase-shift a wide band of frequencies. Circuit is suitable for use up to 1 mc. to obtain 45-degree phase shift; with high slope triode.

—Wireless World (Eng.), January, 1949, p. 23.

A New CRT Power Supply. Suggested use of series resonant circuit consisting of condenser, choke (l.f.), and resistance as a source of high voltage for CRT.

—Break In (N.Z.), March, 1949, p. 11.

INDUSTRIAL APPLICATIONS:

A Watch Rate Recorder. Circuit and details of commercially manufactured (U.K.) equipment. Enables tests to be made to discover intermittent or repetitive faults or irregularities in a watch. To determine differential rate of a watch, the unit consists of a crystal oscillator (low-temperature-coefficient quartz crystal with operating frequency of 81 kc/s.) having frequency stepped down by a frequency-divider. Frequency-divider consists of four multivibrator stages. Recording chart paper is driven at a known constant rate by means of oscillator and frequency dividers and the watch noises are amplified by suitable equipment to provide pulses for driving a printing bar, the latter functioning in conjunction with chart. Full details of operation are given.

—Electronic Engineering (Eng.), February, 1949, p. 39.

MEASUREMENTS AND TEST GEAR:

Cathode Ray Oscilloscope. Details of construction of C.R.O. employing a 3-inch Emiscope (Marconi) tube, with 750-800 volts on final anode. Circuit is suitable for any 3 to 4-inch diameter tube operating with a voltage of 750-1000. Three-valve (hard) time-base is used which generates continuously variable sweep frequency of from 5 to 200,000 c/s. Also embodied in circuit is one-valve signal amplifier and a two-valve wobbulator comprising oscillator and reactor, covering the 465 kc. I.F. band.

—Wireless World (Eng.), December, 1948, p. 432.

Q Meters. A discussion of their function and application. Description of a commercially manufactured (U.K.) meter and its circuit.—**Wireless World (Eng.), January, 1949, p. 7.**

RECEPTION AND RECEIVERS:

A Compact Converter for 6 and 10. Circuit and construction of a converter employing band-switching and suitable for use with a car receiver. Uses 6AK5 valve as broadband R.F. amplifier and a 6J6 valve as mixer-oscillator. Oscillator circuit is ultraudion type. Unit incorporates commercially manufactured slug-type coils.—**QST (U.S.A.), February, 1949, p. 23.**

TELEVISION:

A Method of Controlling Gain in Television Receivers. Outlines method of varying signal amplitude by control applied to the detector stages rather than the H.F. stages. Applies to those receivers employing secondary emission valves in H.F. portions of the set with a view to reducing number of H.F. amplifier stages. Method suggested is variation of impedance in detector load circuit. Impedance consists of two resistors of specified values, in series, and shunted by a high-frequency bypass condenser. The rectified picture signals across combined load impedance are fed to control electrode of the video frequency amplifier valve. Variation of resistance of one of the series resistors provides a range of amplitude control.

—Electronic Engineering (Eng.), February, 1949, p. 44.

Focus Current Stabilizer for TV Receivers. Circuit and short note on method of controlling current through focus coil of an electro-magnetically focused C.R.T. Focus control potentiometer is shunted across lower portion of cathode resistance of pentode p.a. valve in sound channel, and so varies the bias on the valve. A resistance of high value is placed in series with moving arm of potentiometer and grid-stopper resistance in external grid-cathode circuit of valve. The focus coil is in series with field of the loudspeaker in anode circuit.

—Electronic Engineering (Eng.), February, 1949, p. 51.

Television Waveforms. Some comparisons between British and American standards. Two points of difference between the systems are discussed. The differences referred to are, respectively, the sense of modulation and the inclusion or otherwise of equalizing pulses in the synchronizing signals.

—Wireless World (Eng.), December, 1948, p. 439.

B.B.C. Television. History of first public service. Brief outline of development.

—Wireless World (Eng.), December, 1948, p. 1 (Sup.).

British TV Standards. Technical characteristics of the 405-line system. Brief explanation, illustrated.

—Wireless World (Eng.), December, 1948, p. 4 (Sup.).

The Fetish of Lines. Why the 405-line standard is best. Reasoning in favour of the British standard is clearly set forth.

—Wireless World (Eng.), December, 1948, p. 5 (Sup.).

Television Receiver Design. Present trends in British practice outlined.

—Wireless World (Eng.), December, 1948, p. 15 (Sup.).

TV Sync and Inter-Sync Systems: Part III. Sync separator and D.C. restorer action described. Reference to operation of differentiation and integration circuits in TV inter-sync systems.—**Service (U.S.A.), November, 1948, p. 34.**

TRANSMISSION AND TRANSMITTERS:

The "Little Slugger." 10-meter transmitter, low-powered, employing principle of narrow-band F.M. With miniature valves, the units comprising the transmitter are compact. Units are: (1) Oscillator, crystal controlled (3.5 mc.) amplifier-frequency multipliers: (2) P.P. amplifier; (3) speech amplifier and modulator. Transmitter designed with special care to eliminate sources of TV interference.

—**QST (U.S.A.), February, 1949, p. 11.**

Harmonic Suppression in Class C Amplifiers. Design principles for better suppression of harmonics. A comprehensive and practical discussion for the benefit of transmitting amateurs.

—**QST (U.S.A.), February, 1949, p. 28.**

MISCELLANEOUS:

The Van de Graff Generator. Basic description, with later developments and principle of operation explained.

—**Electronic Engineering (Eng.), February, 1949, p. 45.**

The Electronic Measurement and Control of Heat: Part II. High temperatures in industrial processes. Discussion of main methods of measuring and controlling heat where temperatures above approximately 530 degrees Centigrade.

—**Electronic Engineering (Eng.), February, 1949, p. 48.**

Three-phase from One-phase. Description of a method of designing a suitable network for transforming single-phase input to three-phase in the case where input varies over a range of frequencies. Method provides accurate conversion at two frequencies any distance apart and at intermediate frequencies gives conversion in which phase voltages are of correct magnitude but the angles between the phases vary slightly with frequency. Charts provided to assist with necessary calculations. Design procedure outlined and practical application considered.

—**Electronic Engineering (Eng.), February, 1949, p. 58.**

Design for a Brain. (See **Radio and Electronics Abstracts, April, 1949, p. 27.**) Some letters from correspondents engendered by original article. Correspondence consists of letters laudatory and condemnatory.

—**Electronic Engineering (Eng.), February, 1949, p. 62.**

Admittance. Simple explanation of the term and illustration of advantages, at times, of calculating in terms of admittance, conductance, or susceptance, rather than impedance, resistance, and reactance.—**Wireless World (Eng.), January, 1949, p. 29.**

Theory of Error Distribution. Application of theory to navigational aids. Discussion showing application of theory of normal distribution of errors to such problems as the degree of accuracy of a fix depending upon the intersection of two lines in the case of low-frequency C.W. systems, Consol and Decca, or pulse systems, Gee and Loran.

—**Wireless Engineer (Eng.), February, 1949, p. 49.**

TO THE EDITOR

PULSE MODULATION

Sir.—With reference to the letter to the Editor on page 10 of your March issue, and also to the article referred to therein, it seems to me that both the writer of the original article and your correspondent, Dr. Kreielsheimer, have missed the point—that all forms of radar, as the term is generally understood, and neglecting F.M. and C.W. applications, depend **exclusively** on pulse modulation for their operation. The direct historical ancestor of radar is the set of ionosphere sounding experiments of Breit and Tuve, who originated the pulse method. I am not trying to ignore the F.M. method used by other experimenters, nor the present-day applications such as the F.M. radio altimeters, or M.T.I., which is more or less an application of C.W. principles to each discreet pulse, but it must be immediately apparent that pulse transmission is **the** fundamental principle of radar.

I would also like to point out to Dr. Kreielsheimer that a more important attribute in a radar set than minimum range, and one which also requires a short pulse-length, is the ability to discriminate between two targets close together and on the same bearing. This range discrimination is a direct function of the pulse-length, and is, in general, a more important thing than minimum range. For very short ranges, as in the radio altimeter, the F.M. method is rather more satisfactory.—I am, etc.,

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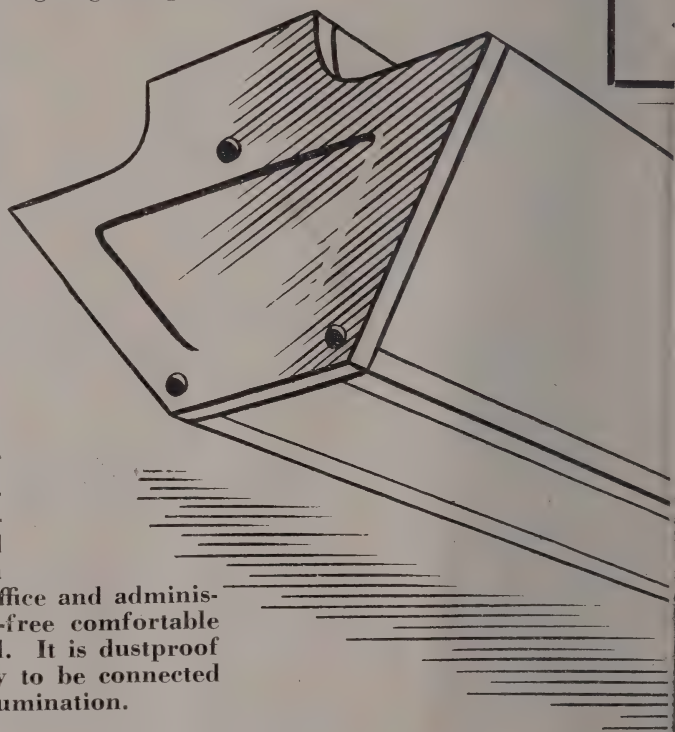

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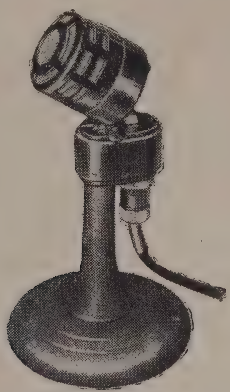
THE EDITOR'S OPINION

THE "RESLO" TYPE P.G.D. DYNAMIC MICROPHONE

This month we have had the opportunity of examining and listening to a sample of the "Reslo" dynamic microphone, which was provided for this purpose by the New Zealand agents, Green & Cooper, Ltd., and we have much pleasure in setting down for the benefit of our readers our impressions of this excellent instrument.



GENERAL DESCRIPTION

The outside form of the microphone can be seen in the photograph, and we can say at the outset that its appearance is very good indeed, and fully in line with the best standards of British workmanship. The satin chromium finish is pleasing to the eye, and one is at once impressed with the standard of the mechanical work that has gone into it. The head swivels on a vertical axis, so that the microphone can be set at any convenient angle for the speaker, and so that the body can be set in an upright position, thereby changing the directional characteristics. A high-quality cord connector is an integral part of the mounting portion, and the latter carries an American ⅝ x 27 standard thread for screwing the microphone to the stand.

The head of the microphone measures only 2 in. x 2 in., in which space the matching transformer is accommodated as well as the dynamic movement. The output impedance is high, and represents several hundred thousands of ohms, suitable for feeding directly to the grid of a valve.

Information provided by the manufacturers states that the diaphragm is of extremely thin aluminium alloy, and is so constructed that the low-frequency resonance which is troublesome in many low-priced dynamic microphones is removed to a frequency so low as to be unharmful to the performance. An interesting point in this connection is that, contrary to popular supposition, this desirable state of affairs can be brought about by using a correctly designed edge support which is stiffly braced rather than extremely compliant, and this method is employed in the present case. A further important feature of the internal construction is that, by allowing only very close mechanical tolerances, in conjunction with the braced diaphragm support, it has been found possible to make the back surface of the diaphragm open to air, instead of to an almost completely closed cavity, as is often done. This has the theoretical advantage of allowing sound-waves approaching from behind the diaphragm almost as good access to it as have those from the front, thereby tending to cancel out the effect of sound other than that arising close to the microphone. This feature enables the microphone to be used much closer to the loudspeakers than many other types, and with less feedback.

PRACTICAL TESTS

It is an unfortunate fact that strictly scientific tests of microphones and loudspeakers can be undertaken only by a limited few who possess the complex and costly equipment which is necessary. Even apparently simple matters like the taking of response curves are very difficult to carry out, and even then require resources such as are available only in the largest laboratories. Others, then, have to rely on listening tests alone in judging the quality of microphones. However, listening is the final test of any acoustic device, even if electrical tests have been carried out, and there are many things that can be judged quite readily from such a test.

Accordingly, the microphone which was sent to us as a sample was fed into a high-fidelity amplifier, of 15 watts undistorted output, which excited a very high-quality dual-unit loudspeaker. The latter was fitted with an efficient dividing network, and was of the type in which the curved cone of the low-frequency speaker forms part of the horn of the high-frequency unit. It can be seen, therefore, that the associated equipment used for the test was of the very best.

With this set-up, speech sounded extraordinarily natural, to the extent that no possible mistake could be made in identifying individual voices. This in itself is a good test of a microphone (and, indeed, of the whole reproducing system). The excellence and flatness of the extended high-frequency response were apparent from the natural way in which sibilants and explosive consonants were reproduced. A microphone which suffers from excessive "top," or from one or more high-pitched resonances, is apt to impress the hearer at first, until he realizes that the s's and t's, and so on, are really grossly exaggerated, after which the instrument is a trial to listen to, but any such effects were notable by their absence in the present case, the effect of "presence" being quite remarkable.

Unfortunately, it was not possible to try the microphone out on music, but it was apparent from the speech tests that the bass register was faithfully reproduced, in that close talking, or talking from a few feet distant, showed no significant differences in reproduced quality; in either case, the lower tones were produced without any suggestion of "boom" or over-accentuation.

A further instructive test that can be carried out by anyone is to listen to the reproduction of various noises, such as would be classed in broadcasting as sound effects. It has been found that it is a very good microphone indeed which will enable a listener correctly to identify such things as the striking of a match or the rattling of keys. It is also an easy matter to judge the naturalness of such reproduced sounds as the clicking of teacups. In the present case, such tests were carried out, and the microphone came through them very well indeed.

(Continued on page 48.)

QUESTIONS and ANSWERS

SOME TROUBLE WITH AN I.F. AMPLIFIER

Mr. R. W. writes as follows: "I have built, with some modification, your Experimental Two-stage I.F. Amplifier Circuit, as presented in "Radio and Electronics" of January, 1947, and am experiencing some trouble which you may be able to advise me upon. I am using two EF39's instead of the EF39 and 6SK7, as in the original, and a 6SN7 as an infinite impedance detector and A.V.C. rectifier. In an attempt to reduce the selectivity, for better broadcast fidelity, I have run into the difficulty that there is considerable distortion present. The method used is to short-circuit the secondaries of the I.F. transformers, and then to choke-couple the grid circuits, each having a grid leak resistor of 500k. ohms. I have tried different values for these resistors, and find that with 100k. and 250k., the distortion is still present. Two of the coupling condensers are 0.0001 μf. and the other 0.00025 μf. The plate decoupling resistors have been increased from the recommended 2000 ohms to 20,000 ohms, because the H.T. voltage is higher than normal. For the same reason, the 100,000-ohms screen dropping resistors go to a voltage divider of 50k. and 100k. In other respects, the circuit is conventional."

Here, the trouble seems to be due, not to the modified grid circuits, as might appear at first sight, because R.W. has tried smaller values of grid resistor without success. Thus, grid blocking does not seem to be the cause. We are as certain as anything can be in this uncertain world that the trouble is due to the modified voltage feed arrangements in the plate and screen circuits of the I.F. amplifiers. In the first place, it is very likely that the screen voltage on the valves is much too low. Also the 20,000-ohm resistors in the plates appear much too high, even allowing for the fact that the H.T. voltage is much higher than normal. We would be able better to confirm this diagnosis if our correspondent had stated just what the H.T. voltage is, as it would then have been possible to work out approximately what the electrode voltages would be. However, the low voltages themselves will not be the cause of the trouble, except indirectly, since the running of the valves on very much reduced voltages will not normally cause trouble, except that the stages will overload more easily than with full voltages on them. But here there is a strong possibility that not only are the voltages all low, but also that the correct ratios between screen and plate voltages have not been maintained, which will undoubtedly cause the valves to overload even more readily.

Our recommendation is therefore to attack the H.T. voltage problem from an entirely different angle. That is to say, the I.F. end of the set should be built with the normal values of dropping and decoupling resistors, after which a voltage divider is used to obtain a voltage of 250 from which to feed the amplifier. This means that a fairly heavy bleed current will have to be accepted if the voltages on the I.F. tubes are not to rise unduly when A.V.C. comes into action. The necessary thing is to see that the bleed current through the voltage divider is rather larger than the current drawn from the tap by the I.F. valves.

THE VENTED BAFFLE AGAIN

E.E., Frankton Junction, writes as follows: "A considerable amount of controversy has arisen among vented-baffle enthusiasts as to the correct method of finding the radius of the speaker cone for the purpose of arriving at the correct measurements for the vented baffle. From my own interpretation of the instructions given in 'Radio and Electronics' of October, 1948, Vol. 3, No. 7, I take it that the playing area only of the cone is to be measured for finding the radius; that the diameter of the voice-coil and the corrugated outer edge of the cone are not to be measured for this purpose. Am I right or not?"

On receiving a number of requests for the elucidation of this very point, we have re-read our own writings on this subject, and have come to the conclusion that the explanation given in the data referred to might have been better expressed; more clearly, that is. There is still one major point of which no readers have spoken, but which could easily cause confusion, even if it has not already done so. It is that the radius is **not** the slant measurement, i.e., measured **along** the cone, but is to be measured **across** the speaker hole, i.e., at right-angles to the axis of symmetry of the whole speaker. To make the measurement, all that has to be done is to lay a ruler across the mouth of the cone and measure the **diameter** from one inside edge of the corrugated "surround" to the other. The required radius is then half the distance measured. This method takes no account of the space occupied by the pole-piece, but this is unimportant, and can be neglected.

One point about the chart that is not always realized is that there really is a certain amount of latitude in the calculation. If the chart is followed exactly, one can be assured of a good result, but this does not mean that slight divergences from the figures given by it will give bad results. To be on the safe side, it is best to stick closely to the chart values, but small differences in the volume of the baffle or the size of the vent are not as important as might be expected. This is a matter which practical experience has shown to be the case, and for which many builders of vented baffles can vouch. We hope that the above exposition has clarified the matter of the cone measurement, but, if it has not, we will be only too pleased to print a diagram illustrating the point, which should not leave the matter further in doubt.

THE RADEL SINGLE-TWIN

R.B.C., Nelson, writes to inform us that in the article on the above set the values of the Condensers C_1 and C_2, and also the gauge of the wire for the coil, were not specified. This is a bad slip on our part, and we make haste to rectify the omission. The tuning condenser, C_1, can be any condenser larger than 0.0003 μf.. maximum capacity, while the reaction condenser can be of 0.00025 μf. or so in maximum capacity. Neither of these is critical. All that really matters about C_1 is that, with the coil specified, it should be able to tune low enough in frequency for 2YA, on 570 kc/sec., to be received. If it is not smaller than the value given, all will be well.

The size of C_2 is governed solely by whether it is big enough for the set to be put into oscillation at the low-frequency end of the dial, i.e., at the 2YA end. If a 0.00025 μf. condenser is used, this will be found more than adequate, but there is no reason why a larger one should not be used if nothing smaller is available. The only difference a larger reaction condenser will make will be that the setting

(Continued on page 48.)

TUBE DATA: THE 7B7 REMOTE CUT-OFF R.F. PENTODE

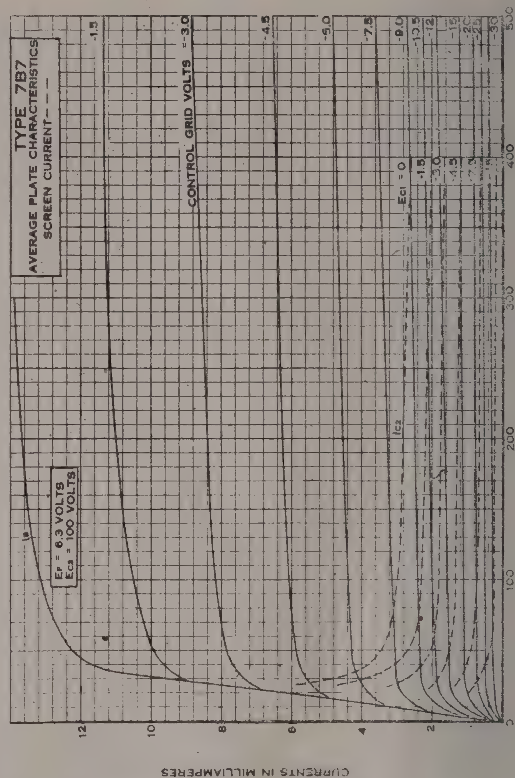
APPLICATION

Type 7B7 is a single-ended triple grid remote cut-off amplifier of lock-in design suitable for R.F. or I.F. service in A.C., A.C.-D.C., and auto receivers.

All of the grids terminate at base pins, thus providing an R.F. amplifier tube without a top cap. An internal cage-like shield connected to pin No. 5 is used to obtain a small grid to plate capacity.

The electrical characteristics and applications of Type 7B7 are very similar to those for Type 7A7.

Base connections and electrode arrangement of the 7B7



PHYSICAL SPECIFICATIONS

Base	Lock-in 8 pin
Bulb	T9
Maximum overall length	2 25/32 in.
Maximum seated height	2¼ in.
Mounting position	Any

RATINGS

Heater voltage (nominal) A.C. or D.C.	7.0 volts
Heater current (nominal)	0.160 amps.
Maximum plate voltage	300 volts
Maximum screen voltage	100 volts
Maximum plate dissipation	2.25 watts
Maximum screen dissipation	0.25 watt
Minimum external grid bias voltage	0 volt
Maximum heater-cathode voltage	90 volts
Direct Interelectrode Capacitances:*	
Grid to plate	0.007 µµf. max.
Input: Grid to (F + K + Gs + Su)	5.0 µµf.
Output: Plate to (F + K + Gs + Su)	6.0 µµf.

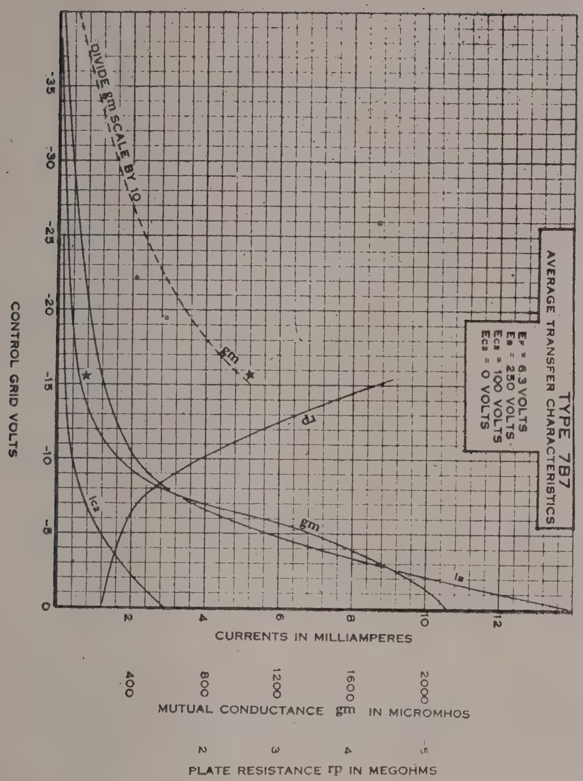
*With 1 5/16 in. diameter shield (RMA Std. M8-308) connected to cathode.

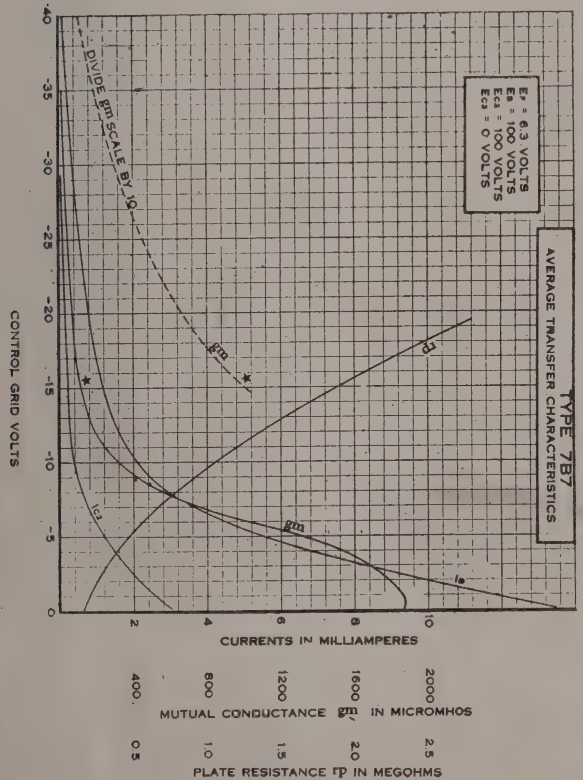
TYPICAL OPERATION

Heater voltage	6.3	6.3 volts
Heater current	0.150	0.150 amps
Plate voltage	100	250 volts
Screen voltage	100	100 volts
Grid voltage	—3	—3 volts
Self-bias resistor		300 ohms
Suppressor	Connect to cathode	
Plate current	8.2	8.5 ma.
Screen current	1.8	1.7 ma.
Plate resistance	0.3	0.75 meg.
Mutual conductance	1675	1750 µmhos
ductance of 10 µmhos	—40	—40 volts
Grid voltage for mutual con-		

LABORATORY PROTOTYPES

Readers who may wish to purchase the laboratory models of equipment described in these pages are invited to write to us for details of prices, delivery, etc. At the moment we have for disposal the original "Junior Communications Receiver" and "Single 807 Audio Amplifier."


TYPE 7B7
AVERAGE TRANSFER CHARACTERISTICS
Ef = 6.3 VOLTS
Eb = 250 VOLTS
Ec2 = 100 VOLTS
Ec3 = 0 VOLTS
DIVIDE gm SCALE BY 10
CONTROL GRID VOLTS
CURRENTS IN MILLIAMPERES
MUTUAL CONDUCTANCE gm IN MICROMHOS
PLATE RESISTANCE rp IN MEGOHMS


TYPE 7B7
AVERAGE TRANSFER CHARACTERISTICS
Ef = 6.3 VOLTS
Eb = 100 VOLTS
Ec2 = 100 VOLTS
Ec3 = 0 VOLTS
DIVIDE gm SCALE BY 10
CONTROL GRID VOLTS
CURRENTS IN MILLIAMPERES
MUTUAL CONDUCTANCE gm IN MICROMHOS
PLATE RESISTANCE rp IN MEGOHMS

A 6-WATT TRANSMITTER

(Continued from page 14.)

ence, mechanically or electrically, between the two types, and they are completely interchangeable. They use the B9G valve socket, which is the same one as is used for the EF50 series of receiving valves. The plate dissipation is 7.5 watts, so that physically the valves are no bigger than a receiving tube which uses the same base. Their frequency ratings extend to beyond the 2-metre band, and a single one can give two or three watts output in doubling or tripling to the 144 mc/sec. band, and more than six watts as a straight amplifier on the same frequency. Needless to say, they are more expensive to buy than a receiving tube, but this is only to be expected in view of their performance, and amateurs will certainly not find that a pair of them will have too adverse an effect on the exchequer, particularly when it is realized that they are really outstanding as multipliers on the lower frequencies and can well be put to use in the main transmitter as well as in V.H.F. gear. They are beam-tetrodes and have a maximum rated plate voltage of 300, and a maximum screen voltage of 250, making them readily adaptable to circuits which would usually employ receiving tubes, with rather less efficiency. The maximum allowable grid current is 6 ma., but maximum efficiency can be got with as little as 0.5 ma. of grid current, even at the highest frequencies for which they are suitable. There is thus plenty of leeway for their driving power, which is really minute at its smallest. Considering their relatively conventional construction, the input and output capacities of these tubes are quite small, being 5.4 $\mu\mu$f. and 8.0 $\mu\mu$f. for input and output respectively.

In case this should read too much like an advertisement for a new valve type, let us say here and now that any laudatory remarks we have made are based not only on the manufacturers' specifications, but on our own experience of them in actual use, and that those who are keen on using newer and better transmitting valves of very moderate cost should not miss the opportunity of trying these out.

In the set-up we are describing, two QEO4/10's are used, one for the last doubler and the other as the straight amplifier.

CIRCUIT OF THE FINAL DOUBLER AND AMPLIFIER

The grid circuit of the last doubler is conventional, as mentioned above, being capacity-coupled from the 6V6 plate. The peculiarity of the circuit of V_3 lies in the method of coupling used between its plate and the grid of the straight amplifier.

This is a modified form of capacity coupling, and is used because it enables a greater value of inductance to be used, and also because it automatically provides a considerable measure of impedance matching between the plate of V_3 and the grid of V_4. Basically, the scheme is illustrated in Fig. 2. Here, it can be seen that the coil, L_4, is tuned by C_{14} and C_{15} in series, and somewhat resembles a circuit tuned by a split-stator condenser. In fact, if the two condensers were equal, the system could be represented as a balanced circuit in which a split-stator condenser is used, and in which the rotor is grounded. However, having the two condensers separately tunable enables the impedance-matching to be brought about at the same time as tuning to resonance, and, in practice, this does not result in an extra tuning condenser which has to be adjusted from the front panel every time the frequency is changed, because C_{14} is pre-set, once and for all, after which C_{15} is used for tuning in the normal way. Fig. 3 shows how the advantage comes about that a larger inductance can be used. At (a) is shown the normal type of coupling, as used here between V_2 and V_3. Here, the input and output capacities of the two valves are directly in parallel with the tuning condenser and the inductor.

COIL DATA

L_1 (18 mc/sec.), 10 t., $\frac{3}{4}$ in. diam., $\frac{3}{4}$ in. long, tapped at 3 turns from earthed end.
L_2 (36 mc/sec.), 5 t., $\frac{3}{4}$ in. diam., $\frac{3}{4}$ in. long.
L_3 (72 mc/sec.), 4 t., $\frac{1}{2}$ in. diam., $\frac{5}{8}$ in. long.
L_4 (144 mc/sec.), 5 t., $\frac{1}{2}$ in. diam., $\frac{1}{2}$ in. long, tapped at centre.
L_6 (144 mc/sec.), same as L_4.
L_5 (output link), 1 t., see text.

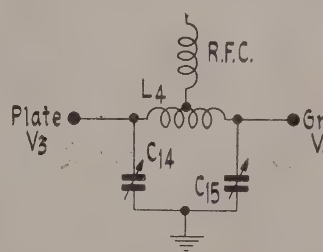


Fig. 2

Because of this, there is a limit on the frequency that can be reached, while retaining a respectable L/C ratio, because of the large minimum circuit capacity. Taking the case of the coupling between the

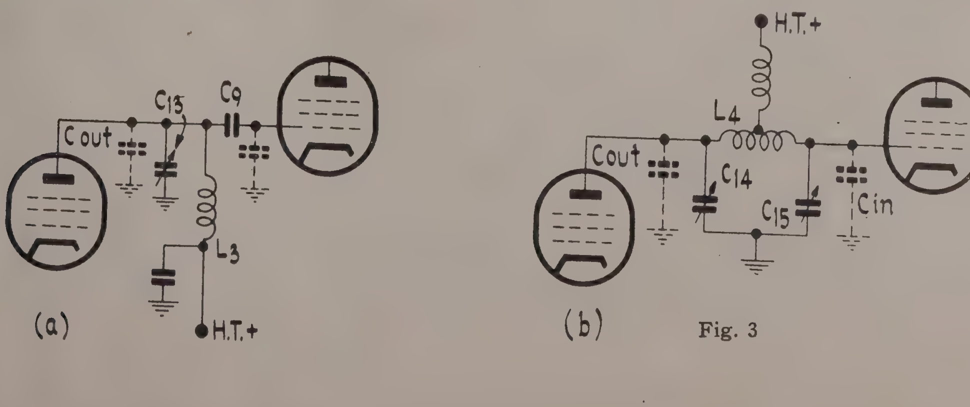


Fig. 3

two QEO4/10's, we have an output capacity for V_3 of 8 $\mu\mu$f. and an input capacity for V_4 of 5.4 $\mu\mu$f. Now, suppose we have a tuning condenser with a minimum capacity of 5 $\mu\mu$f., which is not unreasonably large, the three added together come to 18.4 $\mu\mu$f. To tune the circuit to 148 mc/sec. at the minimum capacity of the tuning condenser requires an inductor of only 0.069 microhenries. This is quite difficult to construct, and in practice is almost unattainable if the turns of the coil are to be of any reasonable size. At (b), however, is the circuit we are using. Here, we have the stray capacities in series across the coil instead of in parallel, so that the valve capacities total 3.27 $\mu\mu$f. If both condensers have minimum capacities of 5 $\mu\mu$f. these have an effective minimum capacity in the circuit of 2.5 $\mu\mu$f., so that the total minimum capacity is only 5.83 $\mu\mu$f. instead of 18.4 μf. With this, an inductance of 0.197 microhenries is needed to reach the band—an improvement of 2.86 times. This is a value of inductance which requires several turns of wire to achieve as long as the diameter of the coil is not too large. It makes the construction less critical therefore, and at the same time improves the L/C ratio and therefore the power output of the previous valve, not to mention, of course, the available grid current in the next.

The same scheme has been used in making the output tank circuit for the straight amplifier. This enables the latter to work at full efficiency and to give a power output that could otherwise be approached only by using a coaxial line type of tuned circuit. Wherever the ordinary L/C circuit can be retained, it has the advantage of ease of construction and small space requirement, and if the efficiency is equal to that obtainable with line circuits, then the latter become not only a refinement but a useless one. This is not to say that we are pointing the finger of scorn at line circuits generally, or that we do not approve of them, for in many circumstances they are the best possible answer to a difficult problem, but we are all in favour of making things as easy as possible for constructors, consistent with good performance.

It will be noticed that the H.T. is fed to the valves through the tuning coils, but that an R.F. choke is used also. This arrangement is similar to those usually employed with an ordinary balanced circuit. Here, as there, the R.F. choke is necessitated only by the fact that it is not practicable to find the exact point on the coil where there is zero R.F. voltage. As a result, the choke prevents undue shunting of the tuned circuit, and at the same time prevents R.F. from getting into the H.T. line. With this arrangement, the chokes are not relied upon as coupling elements, so that it is virtually impossible to strike trouble from T.P.T.G. parasitic oscillation, at the resonant frequency of the R.F. chokes, as can be done with shunt-fed capacity-coupled circuits. It will be noticed that the circuit arrangement allows the rotors of all condensers to be grounded. This may seem a small point, but is in reality a very great convenience, since the unit should be built on a metal chassis and because in this case it is a great deal of trouble to insulate the rotors and shafts of the condensers, as well as being a trifle dangerous should the grub-screws of the knobs be projecting.

CONSTRUCTION

The construction has not been shown in this article, because any straightforward lay-out can be used with success, as long as the important R.F. leads are kept short. Perhaps the most important ones are those which go between the condensers and coils of the tuned circuits. In other words, the coils should be as close as possible to their own tuning condensers, and the fact that the rotors of the latter are grounded should not be relied upon to act as R.F. ground returns. That is to say, condensers should be used which have a wiping contact for the rotor, and the connections of the tuned circuit should always include a wire straight from the wiper to the common earth point of the stage concerned. If this is not done, R.F. currents of some size have to flow through the chassis, and this usually results in high losses, reduced power output, and points on the circuit which should be quite dead as far as R.F. is concerned being "hot" instead.

There is considerable latitude in laying out a circuit like this one, because there is absolutely no need for the tuned circuits to be shielded one from the other, all of them being on different frequencies except the grid and plate circuits of the straight amplifier. Of course, the above remark does not apply to these, and we will have something special to say about the construction of this stage. The multipliers, however, are not at all critical. Perhaps the best lay-out is the straight-line one, where we start with the first tuned circuit, follow with the first valve, and generally line things up as they are drawn in the circuit diagram. In the prototype which was built in our laboratory, however, the arrangement was quite different from this, with valves, coils, and tuning condensers scattered over the chassis-top in an apparently haphazard manner which nevertheless gave the required short leads to the tuned circuits, and also between them and the valves. It is a good plan to choose a single point on the chassis for the earth point of each stage, and, in spite of apparently causing difficulties, sticking closely to this as a principle.

The power level is low in all stages except the amplifier, so that there is no need to bother about polystyrene or similar materials for insulating and for coil formers, though if one wishes to go to the extra trouble and expense, there is no reason why one should not. In our original model, which can be inspected by anyone who may wish to call in to our office, bakelized paper coil formers were used for all except the amplifier grid and plate coils, which were self-supporting and air-wound. These were mounted to the chassis by riveting lugs on to their edges and fixing them down with a nut and bolt. The self-supporting coils were mounted at their points of connection, eliminating leads altogether.

CONSTRUCTING THE AMPLIFIER STAGE

The only part of the whole which needs special consideration is the straight amplifier, which must not oscillate on its own account, but since the QEO4/10's are specially intended for V.H.F., their own internal shielding is such that, apart from a cross-socket shield, no special precautions are necessary. There is certainly no need to neutralize them, even at 144 c/sec., as long as there is no unintentional coupling between the grid and plate circuits external to the tubes themselves; if this should be present, the best way to cope with it is to install better shielding rather than attempt to neutralize the stage.

Constructors will by now have become familiar with the usual method of shielding single-ended re-

ceiving pentodes, and this is exactly the scheme used in setting up this amplifier circuit. The control grid on these valves is pin No. 7, and the plate is pin No. 2. It is therefore a simple matter to fit a baffle-shield across the socket so as to shield one from the other, especially as pins Nos. 5 and 8 are connections for the internal shield and beam-forming plates and have to be connected to earth as solidly as possible. The shield can be made to pass through pins 5 and 8, with a small "kink" in it at the centre so that the centre-connection to the spigot can also be earthed directly to it. It should fit as snugly to the porcelain of the socket as possible, and should be soundly bonded to the chassis on either side of the socket. If the straight-line type of layout is used, a very narrow chassis, no more than four inches wide, will suffice, and the cross-socket baffle-shield can continue right across and be bonded to the sides of the chassis as well as to the bottom.

If these few words are taken to heart (and they are not difficult to comply with), there is no reason why any trouble should be experienced, and the chances are very much against anything untoward occurring. The multiplier chain will be found as amenable as if it were on much lower frequency, and should help, we hope, to dispel some of the disquiet with which many amateurs appear to approach V.H.F. gear.

BEACON TECHNICAL TOPICS

No.13.— Power Transformers

BEACON power transformers are available in both vertical and flat mountings. They are rated to deliver the stated D.C. output current into a condenser input filter. Where applicable, British Standard Specifications are followed in manufacture and testing.

Design sheets, winding sheets, and test sheets containing details of the design, winding, and performance of transformers are carefully filed. From time to time improvements arising from knowledge obtained through manufacturing experience and research are incorporated in BEACON products. The laboratory staff is always ready to discuss technical details of BEACON products with manufacturers of radio sets and other interested people.

A representative list of stock receiver and amplifier power transformers, together with suitable filter chokes, appears below.

Power Transformers

Cat. No.	Rating	Rect.
48 R 01	30 m.a. 150/150v., 6.3v. at 1.5 amp.	6X5
48 R 02	60 m.a. 280/280v., 6.3v. at 3 amp.	6X5
48 R 03	60 m.a. 280/280v., 6.3v. at 2 amp., 5 v. at 2 amp.	5Y3G
48 R 04	60 m.a. 350/350v., 6.3v. at 2 amp., 5 v. at 2 amp.	5Y3G
48 R 05	80 m.a. 280/280v., 6.3v. at 3 amp., 5 v. at 2 amp.	5Y3G
48 R 06	80 m.a. 330/330v., 6.3v. at 3 amp., 5 v. at 2 amp.	5Y3G
4 8R 07	80 m.a. 385/385v., 6.3v. at 3 amp., 5 v. at 2 amp.	5Y3G
48 R 08	100 m.a. 310/310v., 6.3v. at 4 amp., 5 v. at 2 amp.	5Y3G
48 R 09	100 m.a. 385/385v., 6.3v. at 4 amp., 5 v. at 2 amp.	5Y3G
48 R 38	125 m.a. 310/310v., 6.3v. at 4 amp., 5 v at 3 amp.	5Y3G
48 R 10	125 m.a., 310/310v., 6.3v. at 3 amp., 6.3v. at 2.5 amp., 5v. at 3 amp.	5U4G
48 R 11	125 m.a. 400/400v., 6.3v. at 4 amp., 5 v. at 3 amp.	5U4G
48 R 39	150 m.a. 310/310v., 6.3v. at 5 amp., 5 v. at 3 amp.	5U4G
48 R 17	150 m.a. 310/310v., 6.3v. at 3 amp., 6.3v. at 3 amp., 5v. at 3 amp.	5U4G
48 R 13	150 m.a. 400/400v., 6.3v. at 5 amp., 5 v. at 3 amp.	5U4G
48 R 14	150 m.a. 400/400v., 6.3v. at 3 amp., 6.3v. at 3 amp., 5v. at 3 amp.	5U4G
48 R 15	200 m.a. 400/400v., 6.3v. at 3 amp., 6.3v. at 3 amp., 5v. at 3 amp.	5U4G
48 R 16	200 m.a. 500/500v., 6.3v. at 3 amp., 6.3v. at 4 amp., 5v. at 3 amp.	5R4GY
48 R 32	65 m.a. 110v. Half Wave	Metal
48 R 34	30 m.a. Half Wave 6.3v. at 1 amp.	

Filter Chokes

Cat. No.	Rating	Resistance	Cat. No.	Rating	Resistance
48 C 01	Vibrator "A" Choke		48 C 09	250 m.a. 12 Hen	70 ohms
48 C 02	50 m.a. 4 Hen	500 ohms	48 C 10	350 m.a. 12 Hen	70 ohms
48 C 03	60 m.a. 10 Hen	400 ohms	48 C 11	250 m.a. Swinging	
48 C 04	80 m.a. 12 Hen	300 ohms	48 C 12	250 m.a. Swinging, 50 m.a./25H–250 m.a./5H	
48 C 05	100 m.a. 12 Hen	350 ohms			
48 C 06	125 m.a. 15 Hen	275 ohms	48 C 13	350 m.a. Swinging	
48 C 07	150 m.a. 12 Hen	210 ohms	48 C 15	5 amp. Charger Control for 48 R 30	
48 C 08	200 m.a. 11 Hen	160 ohms	48 C 16	4 amp. Smoothing, 0.05 Hen.	

BEACON RADIO LIMITED

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MANUFACTURERS OF DRIVER AND MODULATION TRANSFORMERS, Etc.

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POWER SUPPLY

The power requirements of the unit are very modest indeed, mostly as a result of using as the high-frequency doubler a valve which can give some worth-while efficiency instead of making a receiving tube creak at the knees, as it were, in producing very little output.

No more than 250 volts were used on the original, nor are they needed. The individual plate and screen currents are given below in tabular form, together with the measured screen voltages under the current conditions mentioned. Deviations from these figures can be quite wide, and, indeed, can be expected to be so when different layouts are used, without any noticeable alteration in output or efficiency, and those quoted are intended only as a rough guide to what can be expected.

The oscillator and two doublers can be expected to total no more than 105 to 110 ma. H.T. drain, inclusive of screen currents, and under normal conditions the amplifier will draw another 50 to 55 ma. This gives an overall input of just over 38 watts for an output power of 6 watts R.F., which is really excellent, considering that we have multiplied the original frequency by eight in the process.

TUNING UP THE UNIT

The first job in getting the unit going is to set the oscillator grid circuit on, say, 18.25 mc/sec., so that we will end up in about the centre of the band. This can be done either with an absorption wavemeter, a grid-dip oscillator, or a calibrated receiver. In case the latter is used, care should be taken to ensure that the set is not tuned to the image frequency. When this has been done, a torch bulb, coupled to a one or two-turn link, can be used in setting up the rest of the circuit. If the coils have been made according to instructions and the maximum capacities of the tuning condensers are not greater than the values specified, then there should not be much difficulty in hitting the right harmonics. Still, when the whole thing is tuned up, it is easy to check whether the correct frequencies have been chosen in the doublers by testing the final frequency at the grid of the amplifier. Each doubler should give enough output to light the ordinary 300 ma. torch bulb quite brightly when the stages are doubling correctly. After the oscillator plate has been tuned with the aid of the lamp, the same process should be used for tuning up the plate circuits of V_2 and V_3.

When we come to the latter, the plate condenser, a Philips trimmer, should be set very close to minimum capacity for a start, and tuning performed with C_{15}. If no sign of resonance is found, C_{14} should be slightly increased, and tuning done with C_{15} again. If no setting is found by continuing this process, then the turns of L4 should be spread out a little and the procedure repeated. It is unlikely that there will be any difficulty in finding the frequency, as long as the input to V_3 really is on 72 mc/sec., and there should be little doubt about this. The tuning range of the plate circuit of V_3 is so small that it should not be possible to hit 72 mc/sec. and make V_3 act as a straight amplifier. In any event, should this come about, there will be ample signs of it, since the output will light the lamp to more than full brilliance and in all probability the circuit will oscillate, since it is not intended to be a straight amplifier. When it is thought that everything up to the plate circuit of V_3 is tuned up, a check on the output frequency should be made with the lecher wires. To do this, the lamp is coupled to L_4 and the circuit tuned for maximum output power, as judged by the brilliance of the lamp. The lecher wires are then coupled to L_4 and the shorting bar moved along until the lamp shows a dip in brilliance, indicating that the lecher wires are drawing power from the circuit. The shorting bar is set as closely as possible to the position of minimum brilliance in the lamp, and the setting noted. The bar is then moved again, in either direction, until another such point is found and noted. The distance between the two points is then approximately half a wavelength at the output frequency of V_3. It is not necessary to waste time and effort trying to get an accurate measurement with the lecher wires, as they are only called upon to distinguish between the correct frequency and other multiples of the oscillator frequency, which will be widely different from the correct one should they occur.

In tuning up the valves, it is advisable to plug them in in succession as they are needed, so as not to run them without excitation. There is enough range on the controls to allow all the circuits to be tuned up with or without the next valve in position, so that all that has to be done after plugging in, say, V_3 is to retune C_{13} to resonance to compensate for the input capacity that has been added. If desired, a milliameter can be temporarily inserted in the grid circuits as they are brought into tune, but there is no need at all for permanently measuring the grid currents in the multipliers. When they are all working, only the grid current of the amplifier need be monitored, to act as a tuning indicator for all the multipliers. The reason why this is possible is that when the whole thing is aligned for a particular frequency, quite large changes in oscillator frequency can be made without the amplifier grid current dropping off appreciably, and all that has to be done after re-tuning the oscillator is to bring the other circuits into line.

Although not shown on the circuit diagram, it is a good plan to install a switch which cuts the H.T. supply to the amplifier, so that V_4 need not be run without excitation or load during the tuning-up process. Such meters as may be desired can be installed, but we have left this to the discretion of the individual constructor. However, we recommend either separate plate and grid current meters for the amplifier, or else a single meter which can be switched to measure plate, screen, or grid current in this stage.

ADJUSTING THE AMPLIFIER CIRCUIT

When preliminary checks have shown that the coupling circuit between V_3 and V_4 will tune to resonance, the next thing is to adjust the excitation to V_4. There should be enough power output from the final doubler to drive the amplifier to 2 ma. or so of grid current, even with reduced screen voltage on V_3, as is shown. C_{14} and C_{15} can be used to adjust the excitation to a suitable figure. In doing so, the former is changed slightly in value and the circuit is retuned with C_{15}. It is recommended that the grid current of V_4 be kept down to 1 ma. or so, because if it is higher than this it will be possible to draw so much power output from the amplifier that the maximum rated plate and screen currents are exceeded, even if the dissipation is not. In any event, the total rated cathode current should not exceed 50 ma. if the longest possible life is wanted from V_4. The manufacturers' ratings are, if anything, on the conservative side, and we tested our own output for

some time at a plate current of 55 ma., a screen current of 13 ma., and a grid current of 2 ma. without any apparent ill-effects and without any loss of output or efficiency.

If the drive is too much to enable the plate current limit to be adhered to, it can be reduced either by increasing R_6, the screen dropping resistor for V_3, or by adjusting C_{14} so that when C_{15} is peaked up again the grid current is less. If necessary, both these expedients can be made use of.

When the drive has been adjusted, plate current can be applied to the amplifier and a load coupled in. A single turn of wire, the same diameter as the coil L_6, is used for L_5, and is wedged in between two of the turns of L_9, next to the tap. When C_{16} and C_{17} are tuned to resonance, it should be possible almost to blow out a 6.3v. dial lamp connected to the output link. The latter can feed an untuned transmission line, if the unit is to be used as a transmitter, or can be connected by twisted pair to the input link on the high-powered amplifier, if it is to act as a driver.

A PRECAUTION

It is not always realized that a tetrode or pentode R.F. amplifier must be treated a little more carefully than a triode stage if the valves are not to suffer. In particular, a beam tetrode does not like being run without load, because, when this is done, the screen current rises to quite high values and the screen dissipation may be so far exceeded that the valve is damaged. This is not so important when the screen is supplied from a high-voltage point by a dropping resistor, because, although the screen current may rise, the voltage will simultaneously drop, and, in general, the screen dissipation will not be exceeded, but in a case like this the screen of V_4 being fed directly from H.T., the screen voltage cannot drop if the current rises, and it is easy for excessive screen input to occur. However, no trouble of this sort will happen if the dummy load is kept coupled to the output at all times, so that there is no possibility of running the amplifier with no load. Also, it should be remembered that in tuning up a tetrode Class C stage, the correct tuning point is that which gives maximum power output, and not that which gives minimum cathode current or minimum plate current. This is because the two points mentioned may not always coincide.

In the output tanks we have used the same type of tuning as in the grid circuit, so that the L/C constants can be made similar to those of the grid circuit. Also, having the two tuning condensers enables a certain amount of impedance matching to be done without the necessity for altering the coupling between the tank circuit and the output link. C_{16} can be set at a few different positions, the circuit then being tuned to resonance with C_{17}, and the position of C_{16} is chosen which gives the greatest brilliance in the dummy load or the greatest grid current in the power stage that the unit is driving.

VOLTAGE AND CURRENT READINGS

Voltage and current readings, the former taken with a 1000 ohm/v. meter, are shown in the table below. As mentioned previously, these should not be taken as hard and fast, but should simply serve as a guide to what order of currents and voltages can be expected. In particular, small transmitting pentodes

(Concluded on page 48.)

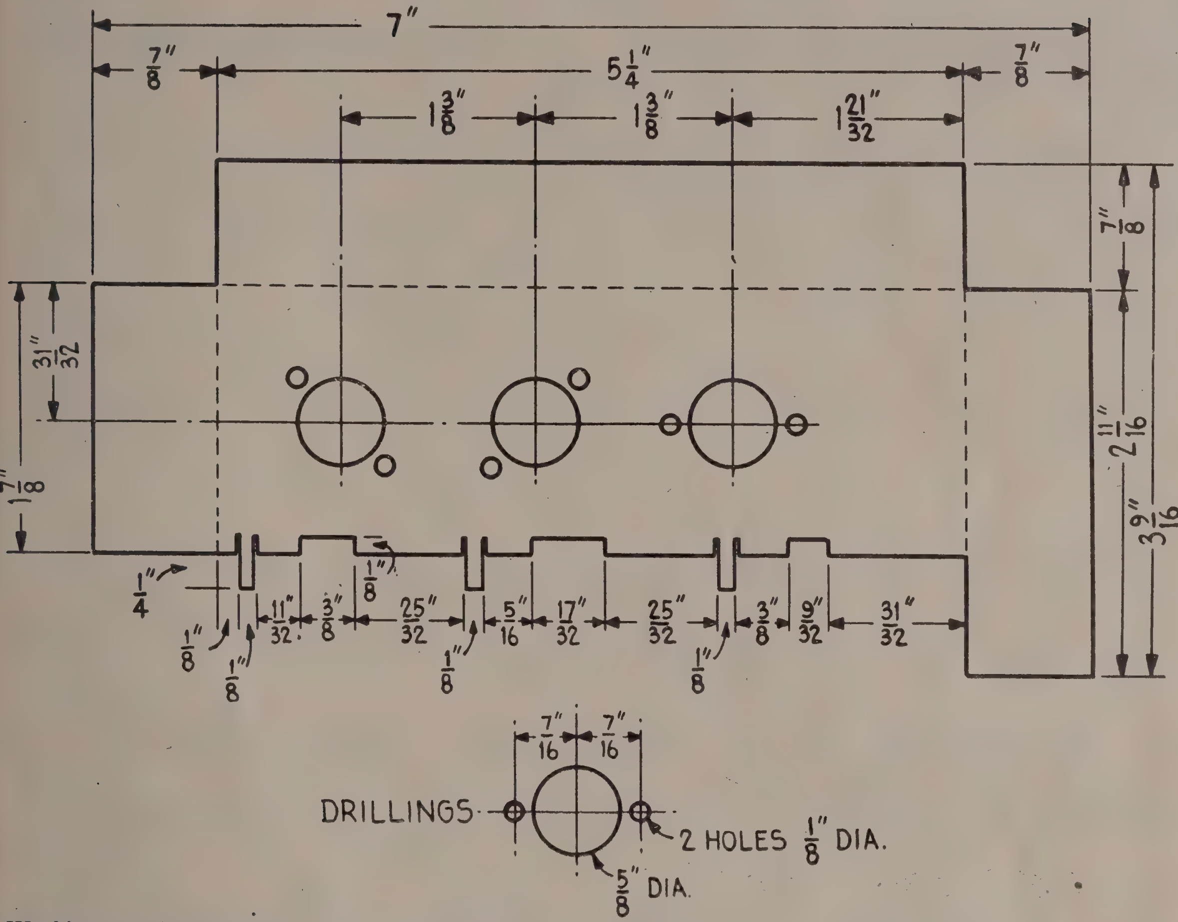
ALL-WAVE TUNER

(Continued from page 15.)

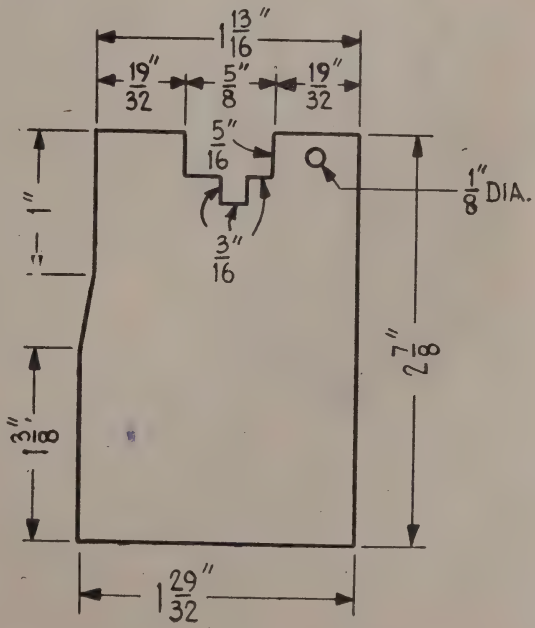
Figs. 1 and 2, in conjunction with the photographs, are self-explanatory, and show not only how the sub-chassis is cut out of the sheet, but also how it is to be bent up after cutting and boring the holes. It will be noticed that small lugs are left on the side of the sub-chassis which is nearest to the contact strips on the turret. These are in the correct positions to come exactly opposite the earthed contact strips, and are bent downwards, and firmly soldered to them, when the sub-chassis is being installed.

The R.F. shield is positioned so that the EF91 socket is crossed exactly between pins 1 and 7, the shield passing through pin 4, which has to be earthed, and can be soldered directly to the shield. A saw-cut is made in the shield, into which pin 4 slides. The socket is turned so that the gap between pins 1 and 7 comes towards the top in the under-chassis view, thereby placing the grid pin in the small compartment to the right of the shield. No special shielding is needed for either the oscillator or mixer tubes. As can be seen in the photograph, insulated lugs for tie-points are mounted on the shield partition on either side.

Fig. 3 shows a suitable chassis lay-out for mounting the unit, with the dimensions of the cut-out shown. This chassis would be suitable where no more than the R.F. unit and its own power supply are to go on the chassis. The I.F. transformer would be mounted in the narrow space to the right of the unit, directly opposite the mixer valve, so that its plate lead may be as short as possible. The large space to



Working drawings for valve panel and its shield, which mounts across the R.F. amplifier socket.



the left and behind the unit cannot be avoided if a symmetrical panel lay-out is to be had, but can usefully be employed by mounting the power transformer, rectifier, and smoothing choke in it. The two valve holes are suggested positions for the rectifier and for a voltage rectifier tube, for those who wish to use one. If there is not enough room on top for the filter choke, this can easily be mounted underneath ,since there will be a large blank space there anyway. The slots, instead of plain holes, for the controls which are already mounted on the turret, make the latter much easier to mount, and enable it to be slipped down vertically into position. The hole at the right is for the 20k. gain control potentiometer, and the one on the left is for an On/Off switch in the power supply circuit, or for an H.T. standby switch.

The 200-volt H.T. point can be obtained by means of a voltage divider from the main H.T. supply.

ALIGNMENT

We do not intend to say very much about the alignment of the unit, since this is covered in the manufacturer's data supplied with it. Our own experience is that if the adjustments are not touched, the unit will be found very close to proper alignment,

(Concluded on page 48.)

RADEL BROADCAST FOUR

(Continued from page 8.)

has been tuned in and identified, the dial scale is fitted and the pointer set to the correct frequency, as read by the dial, while the station remains tuned in. This is only to act as a guide, and not really part of the aligiment. Next, the set is tuned, and the local station near the other end of the dial is tuned in, if possible. If it cannot be found (and it might be off the dial), the best thing to do is to set the pointer to the correct mark on the scale for the station that is wanted, and then, leaving the dial severely alone, to tune it in with the **padder,** C_p. Although the set can still be a good way out of alignment, it will now be much nearer than it was before, and we have a convenient starting point. At this point, some builders, having satisfied themselves that the set will bring in stations, will want to take it off to a serviceman who has the necessary instruments for a proper alignment, and this is a very good idea that we ourselves recommended to all who have had little experience at set-building.

If this course is not to be followed, however, it is still possible to make a tolerably good job of the alignment by ear, and without a signal generator at all, as long as one does not mind a bit of "messing about." The first thing to do now is to disregard what has been done before, and set the dial pointer in such a place that it will travel over the whole scale when the dial is turned from one extreme to the other. The extreme positions of the tuning knob may put the pointer off the calibrated marks at both ends, but this is usual with most dials, and the main idea at this stage is to set the pointer centrally, so that it travels off the scale by approximately equal amounts at each end.

Now, an aerial should be attached to the set and a search conducted for stations near the high-frequency end of the broadcast band. When one is found, it should be identified, whereupon a look at the log of stations will tell us its frequency. In any case, it will probably be marked on the dial. The next thing to do is to set the dial to where this station should come, and then tune it in with the **oscillator trimmer.** When this has been done, we have the selected station coming in at the right spot on

the dial. Next, we turn the **aerial trimmer** until the signal is loudest, and leave it at this setting, just as we did with the I.F. trimmers. The important thing for the novice to realize is that, basically, it is the oscillator tuning that determines **where** a given station will come on the dial, while the aerial trimmer will only regulate its strength, according as it is properly tuned or not. Having got thus far, we must now have a go at the oscillator padder. Now, the oscillator trimmer and padder settings are almost independent, but not quite, as will appear, but at the start we will imagine that they are so. This being the case, the trimmer can be said to regulate the position of the high-frequency stations of the band, while the padder regulates the low-frequency stations, both as to position on the dial and as to strength also. The aerial trimmer and the oscillator trimmer are NEVER adjusted with the tuning condenser even half meshed, while the padder should likewise NEVER be touched except when the tuning condenser is nearly all the way in. Thus, after we have made our initial adjustment of the trimmers, which are **always and only** used at the high-frequency end of the scale, we go over to the other end to adjust the padder, leaving the trimmers strictly alone. Now, adjusting the padder will alter both the strength of a low-frequency station and also its position on the dial. Now, the latter is really a secondary consideration, as we want most of all to have the sensitivity of the set as even over the dial as possible. For this reason, we adjust the padder as follows. The padder is altered, one way or the other, it does not matter which, and the tuning condenser is rotated to keep the station properly tuned in. There will be some position on the padder at which, after the main dial has been retuned, the signal is strongest, and the simultaneous adjustment of the two, as described, has as its purpose the finding of this setting. One good reason for using the instruments in aligning a set is that this padder adjustment is not easy to find unless we have something better than the unaided ear with which to judge when the signal is strongest. If the set had no A.V.C., the job would be easier, but the A.V.C. is working against us and trying to flatten out the effect of our adjustment, but, luckily, we have an excellent output indicator in the person of the magic-eye tube, especially when the signal into the set is kept small. This can be done quite easily by using only a few feet of wire as an aerial.

While the padder is being adjusted, in conjunction with the main tuning dial, it is important to go only by the output indication and to ignore the dial settings, as these will change with changes in the setting of the padder. After the best setting for the padder is found, we return to the high-frequency end of the band, and we will find that our station has shifted slightly on the dial. This again is because we have altered the padder, and now is the time to re-set the pointer so that it indicates the high-frequency station at the right place. When this has been done **by shifting the pointer,** the **aerial** trimmer is again adjusted for greatest output. We return once

OUR GOSSIP COLUMN

NEW H.M.V. FACTORY

At the opening ceremony on 30th March of H.M.V. (N.Z.), Ltd.'s new fatctory at Kilbirnie, Wellington, the Hon. Robert Semple, Minister of Works, pressed the first record of this new gramophone record industry. Addressing the gathering, Mr. Semple emphasized that he had always been an advocate for a nation standing on its own feet and becoming more self-reliant. This new factory, though perhaps considered small by some, was but another step by New Zealand in achieving that result.

Mr. R. Semple (left) receives the first record from Mr. A. J. Wyness.

Many visitors, including members of the radio and musical instrument industries, thronged the commodious ground floor of the new factory, previously known as the Taia Hall, Kilbirnie. Completing the full and interesting programme, the afternoon tea reception was held in the spacious and gaily-decorated second floor.

In the absence of Mr. A. Wyness, who is on his way to England, Mr. A. J. Wyness, deputy managing director of H.M.V. (N.Z.), Ltd., presided over the gathering, ably assisted by the secretary, Mr. Bull.

* * *

PIONEER STANDS DOWN

For more than 50 years actively associated with the forward march of New Zealand electrical development, Mr. Nelson Jones, managing director of the National Electrical and Engineering Co., Ltd., recently retired from business life.

MR. NELSON JONES

The National Electrical and Engineering Co., Ltd., came into being on 13th October, 1906, with Mr. E. W. Ackland as manager and Mr. Nelson Jones as foreman. They comprised the entire staff at that time. To-day the company ranks as a leader in the New Zealand electrical engineering field, and has factories at Auckland and Wellington with combined staffs numbering several hundreds.

Early this year Nelson Jones relinquished his post

as representative of the electrical trade on the Electrical Regulations Advisory Committee, where he had served almost continuously since 1929. He was also an original member of the Electrical Wiremen's Registration Board, holding office from 1926 till November, 1933.

World War II again saw Nelson Jones in uniform, being mobilized with the National Military Reserve following the outbreak of war with Japan. He had previously seen active service in the South African War at the beginning of the century, and again throughout the war period 1914–18.

During his many years with National Electric, Nelson Jones held executive positions in each of the four main centres, and at one time was in control of a London office opened there by the company in 1919. He was appointed managing director in 1942, following the death of Mr. E. W. Ackland earlier in that year.

We feel sure that their many friends, both here and overseas, will join with us in conveying to Mr. and Mrs. Nelson Jones sincere good wishes for a long, happy, and well-merited retirement, which will be spent in Nelson.

* * *

A keen yachtsman, Albert Le Seur, of Radiart Co., Wellington, after adding another second and third to his record with his 42-foot keeler "Rona" during the first week-end in April, has now carried off the P.E.T. Cup and the Hutcheson Wilson trophy by securing first place in these events on 9th April. Our congratulations, Albert. It looks as though April is your lucky month.

* * *

NEW DIRECTOR OF BROADCASTING

The appointment has been announced of Mr. William Yates as Director of Broadcasting in place of Professor James Shelley, whose retirement commenced at the end of April. Joining the Broadcasting Service in 1934, Mr. Yates has since enjoyed a wide and varied experience in this department, previously occupying the position of Assistant Director of Broadcasting. During recent visits to England, Canada, and the United States of America, Mr. Yates has made an intensive study of up-to-date methods of broadcasting administration and overseas trends in broadcasting techniques which will, no doubt, have important repercussions on the service in New Zealand.

* * *

ARNOLD & WRIGHT'S NEW PREMISES

As this issue goes to press, Arnold & Wright, Ltd., Wellington, announce their removal to their new premises at 171–173 Taranaki Street, where they have secured ground-floor space covering some 6000 square feet.

The PHILIPS Experimenter

No. 19: A FOUR-BAND EXCITER UNIT FOR 80 TO 10 METRES INCLUSIVE (Continued)

PLUG-IN COILS FOR THE AMPLIFIERS

The band-switching applies only to the three doublers, plug-in coils being used in the grid and plate circuits of the amplifier stage. In the next issue of the Experimenter it will be seen that an ingenious mechanical arrangement is used whereby the coils are plugged in in pairs, so that only one plugging operation is needed for each band-change instead of two. This may not be quite so convenient as having the exciter switched throughout, but it has the great advantage of doing away with the necessity for two four-band coil assemblies for the QE04/10 stage, together with their switching arrangements. It also makes for more efficient operation of the amplifier, which is, after all, working at a reasonable power level.

THE DOUBLER CIRCUITS IN DETAIL

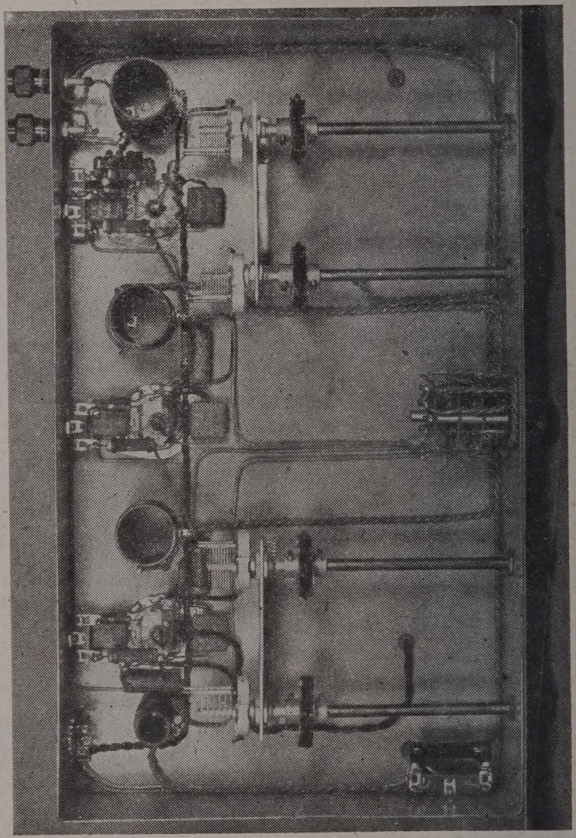
Apart from the band-switching arrangements, the circuits of the doublers are conventional to the point of being ordinary. Capacity coupling is used between stages, as is series plate feed in all cases. The stators of the tuning condensers are at H.T. voltage, but since this is only 250 volts, there is no difficulty on that account. It will be noticed that the only grid circuit to have an R.F. choke in series with the grid leak resistor is the first one. The reason for this is that the output of each multiplier is somewhat greater than that of the V.F.O., and the slightly increased grid current achieved in the first multiplier through the insertion of the R.F. choke is not needed in the others. Each doubler has a 200-ohm cathode resistor, whose purpose is that of providing protective bias so that when the plate circuit is detuned—or the grid circuit, for that matter—the loss of grid leak bias will not result in excessive plate current and screen dissipation. The screens are fed through 25k. dropping resistors, which are themselves an insurance against too much screen dissipation. The suppressors are all connected directly to their respective cathodes at the sockets.

VALUES IN THE L/C CIRCUITS

As in most pentode multiplier circuits, the constants of the tuned circuits are not at all critical, as long as the correct tuning rangs is covered. Many amateurs will have their own ideas of the best L/C ratios to use, and in practice the capacities needed to tune the coils to resonance can vary between 1 and 2 $\mu\mu$f. per metre without sensible alteration in performance. That is to say, on 80m., a capacity in use, of anywhere between 80 and 160 $\mu\mu$f. will be suitable, with correspondingly smaller values on the higher bands. The tuning condensers can have maximum capacities of 100 $\mu\mu$f. in all cases except that of the third doubler, where a maximum of 25 is slightly more manageable, since here the capacity actually in use should be between 10 and 20 $\mu\mu$f. It is a good idea to allow the L/C ratios to become progressively smaller as the frequency of the band increases, as doing so makes the coil winding less critical.

In our own experimental version of the exciter, the coils were wound as follows:—

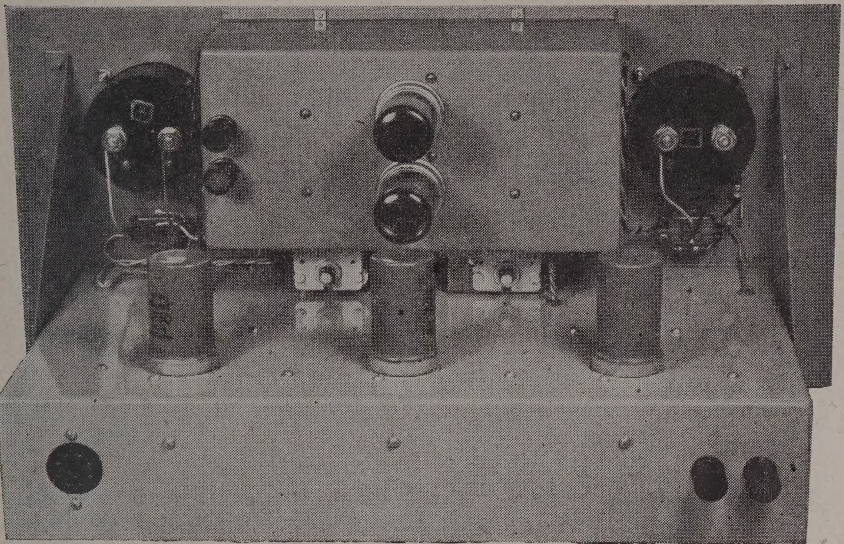
	1st Doub. Grid	1st Doub. Plate	2nd Doub. Plate	3rd Doub. Plate
Freq.	80m.	40m.	20m.	10m.
Diam.	1¼ in.	1¼ in.	1¼ in.	¾ in.
Wire	20 en.	20 en.	20 en.	20 en.
Winding	Close	Doub. spaced	Doub. spaced	To occ. ¾ in.
Turns	36	15	10	9



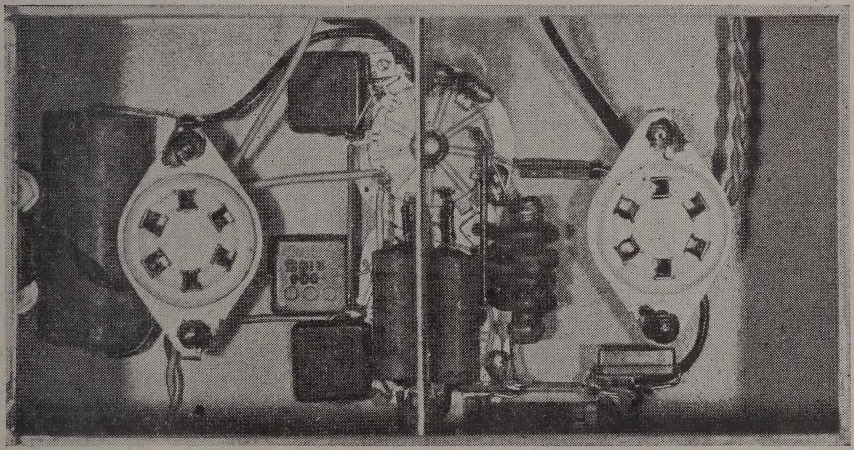
Underneath view of the main chassis. The input terminals can be seen at the top left corner, next to the 80m. tuning coil of the first doubler. The wire-wound resistor in the bottom right corner is the screen-dropping resistor for the QE04/7 stage.

PRACTICAL SET-UP

The three photographs on these two pages give a god idea of the way in which the exciter was constructed. In next months' Experimenter we will complete the description by printing further photographs,



Top-chassis view, showing the sub-chassis, mounted on the panel, which contains the amplifier circuit. The two QE04/7's can be seen mounted horizontally on the back of this chassis. The terminals on the left of the sub-chassis are the R.F. input terminals. The two variable condensers under the sub-chassis are those for the grid and plate tanks of the amplifier.



View looking into the sub-chassis through the rectangular hole in the front panel. The coil sockets can be seen, and the baffle-shield across the valve sockets. The top one of these is hidden by two of the bypass condensers. The lid for the sub-chassis can have the grid and plate coils for the amplifier mounted on it, so that they can be plugged in in one operation. This would need four identical lids. The front view of the unit will be given in the concluding instalment next month.

and a working drawing for the chassis-work that is required if our lay-out is to be duplicated. Of course, there is no need to do this, as any straightforward lay-out can be used. It is recommended, though, that the multiplier circuits are laid out exactly as in the photograph of the underneath of the chassis. This places the components in the exact sequence in which they appear in the circuit, which is really the best possible arrangement. The photograph shows the construction very clearly indeed. As can be seen, the tuning condensers are mounted well behind the front panel, and are operated through extension shafts. The purpose of this is to keep all the R.F. leads (except the low-impedance links) as short as possible, and in particular those of the tuned circuits themselves. The condensers are mounted in pairs on two brackets, between which is the wave-change switch, which is mounted on the front of the chassis. There is no need to worry about keeping the twisted-pair lines short, as the impedance is low, thanks to the small coupling links on the tank coils, and they can be run as far as we like without introducing losses that are great enough to matter.

The H.T. leads are also run to the wave-change switch, as shown on the circuit, but it is important to note that these leads are all bypassed right at the valve sockets. It has not been found necessary to use decoupling resistors in these leads, but this is only because each stage operates on a different frequency from all the others, thereby rendering regeneration very unlikely from the start. However, when our own unit was beiug constructed, a fault occurred which was very difficult to locate until it was realized that the first doubler was oscillating. This is mentioned because others may strike the same trouble, unless they apply the remedy that we ourselves found successful. The lower end of the 200-ohm cathode resistor was connected, not directly to earth, but to earth through a meter shunt, so that the cathode current could be measured, It was found that under

these circumstances a 0.002 μf. bypass condenser across the cathode resistor was not large enough, and that regeneration took place. This resulted in the first doubler oscillating weakly on its own account. The oscillation could not be noticed when the V.F.O. was attached to the input, and was probably suppressed by the input, but it was found that with the V.F.O. turned off, the second and third doublers were giving output! However, a 0.1 μf. condenser placed in parallel with the 0.002 μf. already there cured the trouble completely. In the original experimental work, this "bug" was not present, because the metering circuit was not included.

EDITOR'S OPINION

(Continued from page 27.)

In brief, our opinion is that the "Reslo" dynamic microphone bids fairly to equal the performance of other types and makes that are acknowledged as leaders in the field, and when it is considered that the price is definitely in the medium class, one has an an instrument which must be very difficult to better on a price-for-performance basis.

QUESTIONS AND ANSWERS

(Continued from page 28.)

to the point where the set is just not oscillating will be a little more difficult to find accurately, but this can be eased by using a slow-motion drive. The gauge of the wire for the coil can be 24 double cotton covered, but a gauge or so either way will make very little difference if 24 gauge cannot be obtained.

DESIGN SHEET NO. 6

(Continued from page 17.)

make an oscillator for 100 kc/sec.

First of all, we look up the resistance-coupled data on the 6SJ7 in the tube manual, and find that with a plate supply voltage of 300, a plate load resistor of 100k., a screen dropping resistor of 500k., and a cathode resistor of 600 ohms, the valve has a gain of 104 times.

We now have that R_1 is 100k., and that $A = 104$.

Referring to Fig. 2, or using the formula, we find that the minimum theoretical value of R is 31k. approximately. It will be noted that this certainly does not make R very much greater than R_1, but actually less, so that as long as R is made more than 62k., there is very little possibility of oscillation not occurring, as long as the valve is up to standard. To allow a greater safety factor, we will fix R at 100k.

Now, all that is left to fix is the capacity of C. Reference to the abac shows that for a frequency of 1000 c/sec. and an R of 100k., the value of C should be 650 $\mu\mu$f., and that if 500 $\mu\mu$f. is used as the nearest available value, the frequency will be 1400 c/sec. To take care of this, one of the resistors R can be made from a 100k. resistor in series with a 100k. potentiometer, connected as a variable resistor. This will give some adjustment to the frequency. The cathode resistor is made, say, 1000 ohms, with a 5000-ohm rheostat in series with it, so that the circuit can be adjusted so that it just oscillates and the waveform is good. This completes the design.

There is no need to use such a low value of R if one wishes to use smaller condensers C, since raising the value of R will only make the available gain still more adequate to sustain oscillation. The chart, Fig. 2, is for giving the MINIMUM possible value of R when the gain A is known.

6-WATT TRANSMITTER

(Continued from page 37.)

and tetrodes (and even big ones, too, as many will have found out) do not always give the plate currents that are expected of them. Under apparently ideal conditions, a number of valves plugged into the socket can show quite wide variations of plate and screen current, but, in general, and unless the tube happens to be defective, the power output will vary hardly at all. This is the main consideration, as long as the current figures are not excessive. Thus there is no need to worry unduly if the QEO4/10's take more or less current than they are expected to, as long as they give the power output without getting too hot.

Valve.	Plate Volts.	Screen Volts.	Plate Current.	Screen Current.	Grid Current.
V_1	250	160	21	4.5	1.6
V_2	250	200	40	3.0	1.4
V_3	245	200	34	3.0	2.0
V_4	250	250	46	4,0	0.5

ALL-WAVE TUNING UNIT

(Continued from page 39.)

and that those without benefit of signal generator and output meter would be well advised to leave a final tune-up to someone who has the necessary equipment. The performance of these units leaves very little to be desired, even at 30 mc/sec., and this is specially so if the low-noise mixer and R.F. stage are used in preference to conventional tubes.